TOBER
1984
$2.30
$3.30

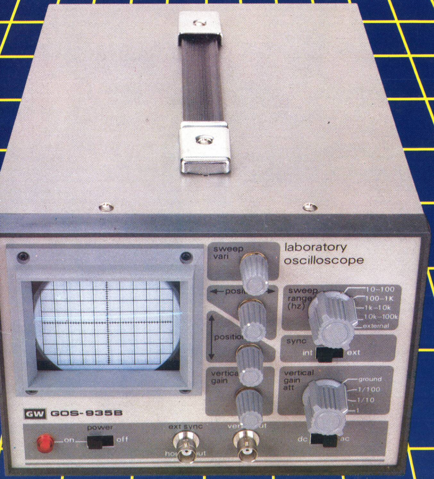
Australia's Top Selling Electronics Magazine

Electronics Australia

STEREO DECODER FOR AM RADIO

troduction to amateur radio

uild this scilloscope



Temperature probe for your digital multimeter

REVIEWS:

Challenger computer

Philips CD303 player

It had to happen!
Teletext for only $199

Unbelievable . . . but true!

Now you can save hundreds of dollars on the technological breakthrough of the decade: Teletext!

Hundreds of pages of information — at your fingertips — that you haven't had access to in the past:

- Sport
- News & Weather
- Finance
- Education
- TAB details
- Theatre programs
- Even captions for the deaf . . .
- And much, much, much more!

AND THE BEST PART OF ALL:
IT'S FREE COMPLIMENTS OF YOUR LOCAL TELEVISION STATION!*

At last, a low cost, easy-to-build kit that you can use with your VCR to give sharp, clear Teletext pictures on any TV set.

EXCLUSIVE TO

DICK SMITH ELECTRONICS PTY LTD

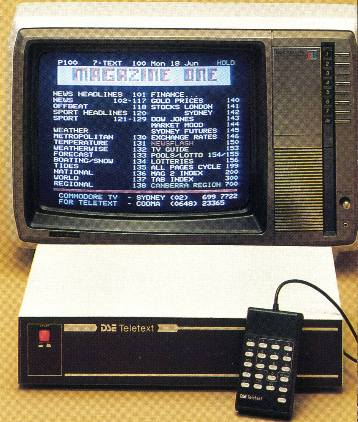
Don't pay $500-$700 for a Teletext decoder . . . or even $1000-$1200 for a new 'Teletext' TV: build it yourself only **$199**

See centre section for address details.

Cat K-6315

And it's complete to the last nut and bolt — including the deluxe two-tone brown case shown here PLUS our exclusive step-by-step construction manual!

*Not all stations transmit Teletext. Stations in the 7 network (ie those taking Channel 7 news) do as well as ABC stations, and many others have some Teletext transmissions. Most stations transmit Teletext subtitles for deaf people. If in doubt, ring your local station.



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         MAGAZINE ONE

NEWS HEADLINES   101 FINANCE...
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OFFBEAT          118 STOCKS LONDON    141
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NATIONAL         136 MAG 2 INDEX      200
WORLD            137 TAB INDEX        300
REGIONAL         138 CANBERRA REGION  700

 COMMODORE TV  - SYDNEY (02)    699 7722
 FOR TELETEXT  - COOMA  (0648) 23365
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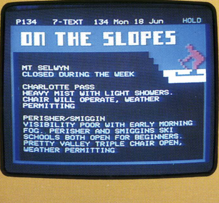

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P134   7-TEXT  134 Mon 18 Jun     HOLD
ON THE SLOPES

MT SELWYN
CLOSED DURING THE WEEK

CHARLOTTE PASS
HEAVY MIST WITH LIGHT SHOWERS.
CHAIR WILL OPERATE, WEATHER
PERMITTING

PERISHER/SMIGGIN
VISIBILITY POOR WITH EARLY MORNING
FOG. PERISHER AND SMIGGINS SKI
SCHOOLS BOTH OPEN FOR BEGINNERS.
PRETTY VALLEY TRIPLE CHAIR OPEN,
WEATHER PERMITTING
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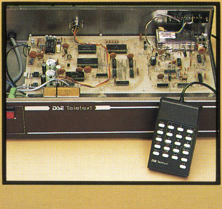

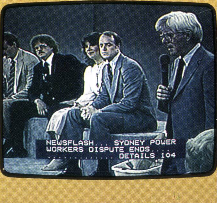

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NEWSFLASH... SYDNEY POWER
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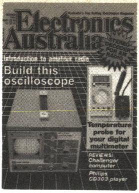
Electronics Australia

Volume 48, No. 10,
October 1984


Electronics Australia
Introduction to amateur radio
Build this oscilloscope
Temperature probe for your digital multimeter
REVIEWS: Challenger computer
Philips CD303 player

If you can't afford the big bickies for a 10-20MHz CRO why not build the unit on this month's cover. The specifications may be quite modest but so is the price. Inset shows our new Thermocouple Probe which measures temperatures from —17°C to 350°C.

Features

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77 **COMING NEXT MONTH** *Sneak preview for November*
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52 **TEMPERATURE PROBE FOR DMMs** *Checks temperatures from —17°C to 350°C*
62 **BUILD A LOW-COST OSCILLOSCOPE** *Modest specs with price to match*
80 **FET-INPUT ELECTRONIC MULTIMETER** *Build it and learn*
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We visit IBM's Wangaratta factory

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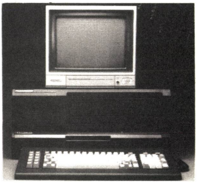
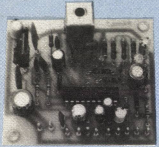
Challenger computer reviewed



DSE's Challenger is one of the least expensive computers to claim compatibility with the IBM PC. It comes complete with DOS, full Basic A, and the "Perfect" series of word processing, spreadsheet and database management programs.

Stereo decoder for AM tuners

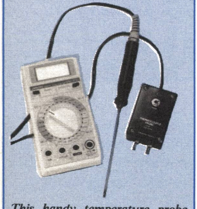


AM stereo is now broadcast in Australia. This add-on decoder works with the Motorola system. We show you how to build it and how to add it to your tuner (see page 34).

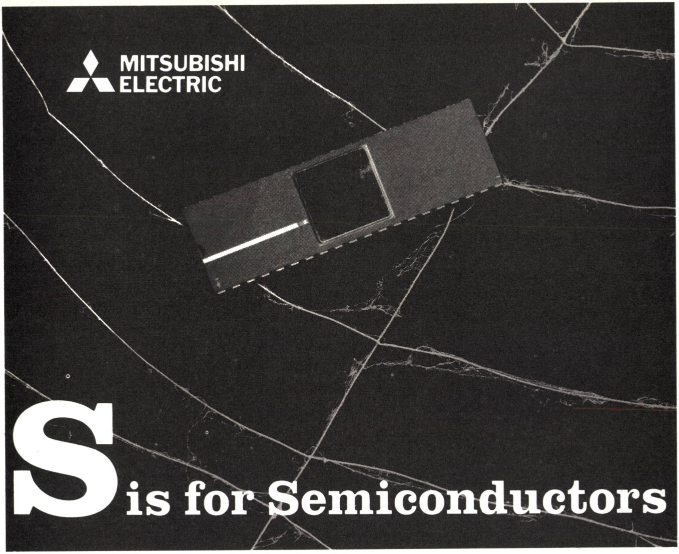
What's coming

Next month, we intend to describe a sound effects circuit for model trains, a couple of general purpose audio amplifier modules and a versatile electronic crossover circuit (see also page 77).

Temperature probe for DMMs



This handy temperature probe plugs directly into your digital multimeter and can measure temperatures from —17°C to +350C. Construction begins on page 52.



No matter whether you need Integrated Circuits, Hybrids, Transistors, Power Semiconductors, Power Modules, or Opto Semiconductors, the place to look is right here. We've got them all.

Integrated Circuits include Memories, Single Chip Microcomputers Microprocessors and LSIs for peripheral circuits, Standard Logic ICs, and a whole range of Special Purpose ICs for tape, radio, television, timing, calculating and other applications. The more popular types are stocked, in depth, in Australia.

When it comes to Hybrids, we can supply a comprehensive line-up of Mobile Communication types and specialist devices for both consumer and industrial applications.

Transistors and Diodes are easy to order, too. We offer a wide choice from small signal transistors up to Ga As FETs for Microwave Band use.

Under the general heading of Power Semiconductors and Power Modules we have rectifier diodes, thyristors, triacs, high power transistors, power modules, trigger devices, thermal thyristors, pnpn switches and solid state relays.

Opto Semiconductors include lasers, high radiance LEDs and avalanche photo diodes.

All of our semiconductors are clearly outlined in one easy to read book. And it's easy to obtain . . . just give us a call and we'll put one in your hand.

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Subscriptions Subscription Dept, John Fairfax & Sons Ltd, GPO Box 506, Sydney 2001. Enquiries: Phone (02) 699 2388.

Registered by Australia Post — publication No. NBP0240. ISSN 0313-0150

*Recommended and maximum price only.

Printed by Magazine Printers Pty Ltd, Regent Street, Chippendale and Masterprint Pty Ltd, Dubbo, NSW for Magazine Promotions, Regent St, Chippendale.

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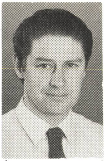
Distribution: Distributed in NSW by Magazine Promotions, 57 Regent St, Chippendale; in Victoria by Magazine Promotions, 392 Little Collins Street, Melbourne; in South Australia by Magazine Promotions, 101-105 Waymouth St, Adelaide; in Western Australia by Magazine Promotions, 454 Murray Street, Perth; in Queensland by Gordon and Gotch (A'asia) Ltd; in Tasmania by Ingle Distributors, 93 Macquarie St, Hobart; in New Zealand by Gordon and Gotch (NZ) Ltd, Adelaide Rd, Wellington.



Editorial Viewpoint

The attractions of Amateur Radio

This month we are featuring the first of a two part series on amateur radio. These articles had been planned for quite some time so it is with considerable satisfaction that we see them in print.

The reason we were so keen is that amateur radio represents an important branch of the electronics hobby. Not only has it led many people to a satisfying career but it has also provided an important national resource in times of war and emergency. Most people have heard of the crucial services provided by amateurs in times of flood and bushfires. Anything which can be done to encourage the growth of this communications capability will be for the good of the community at large.

But there is another reason why we are interested in the growth of amateur radio. It is painfully obvious that the general populace is in love with the products of the latest technology. Whether it is the latest hifi VCR, compact disc player or other what-not, the Australian public loves it. As an example of this, Australia has one of the highest market penetrations for VCRs in the world.

Unfortunately, while this new technology becomes ever-more dominant in our lives, the proportion of the population who actually understand how the technology works is becoming smaller and smaller. Amateur radio operators, on the other hand, have an express interest in understanding and developing the technology they have access to.

Yet another reason for promoting the growth of amateur radio is that this hobby is aimed at fostering communication between people, whether they are within the same suburb or on the other side of the world. That is an extremely important aim because many Australians are quite poor at communicating with each other. This is in direct contrast with other electronics activities, particularly those involving computers, which seem to encourage the introverted person to become even more so.

Too many hifi brands and models

Anyone walking into a hifi store these days is confronted with a bewildering array of equipment. There are literally hundreds of different models of turntables, amplifiers, receivers and loudspeakers. Even compact disc players are available in several dozen different models.

The problem with this vast plethora of equipment is that most of it is unnecessary and merely confusing to the consumer. Most of the model differentiations in a given brand range are often artificial. The differences amount to perhaps another knob or two, a slightly different display or perhaps a slight increase in power which is of no audible importance.

The large Japanese companies are mostly to blame for this state of affairs. While some marketing people may celebrate the fact that the consumer has a very wide range to choose from, the fact is that the Japanese companies have far too much production capacity and are seeking to use it to the full by producing many diverse models. It is time to call a halt.

These Japanese companies should realise that automated plants or not, it still costs more to make, deliver and store a wide range of equipment than a more limited range. Certainly the retailers can vouch for the fact that it costs more to stock a wide range.

Perhaps the initiative lies with the retailers. If they make the decision to stock a smaller range of equipment they will be helping themselves and their customers.

Leo Simpson

JAYCAR

OSCILLOSCOPE SENSATION!

Ref: EA October 1984

NEW

Jaycar and EA have come up with the best value Oscilloscope on the market today - **IN A KIT. . .**

Over the years many people have asked, "Do you have a CRO kit?" Our answer - up until now - has been that built and tested units were no dearer than kits, if you could get a kit at all.

The Jaycar KJ-7050 Cathode Ray Oscilloscope kit has a guaranteed 5MHz bandwidth but should go to around 6.5MHz. It also features 75mm (3") CRT Blue Phosphor with accurate graticule, separate vertical and horizontal BNC type input sockets etc. Remember, a 5MHz 'scope is usually adequate to troubleshoot most micro processor and other digital circuitry as well!

This is a wonderful opportunity to learn electronics AND end up with a valuable piece of test equipment as well.

The Jaycar KJ-7050 kit is absolutely complete. The chassis is prepunched and every component including nuts and screws are provided, along with instructions.

Cat. KJ-7050

ONLY $229

"RED LIGHT" ALARM FLASHER

NEW

Not a kit - Built and Tested

This unit is basically an assembled version of our KJ-7000 flasher kit. It consists of a high-quality German made push switch which has a large illuminated button when pressed. It is the same switch that is used in the professional flashing dashboard light type alarm systems so it looks the same to the thief as the real alarm! You get the deterrent value of the $300+ alarms at 10% of the price. (Note that it's just a flasher NOT an alarm). We even throw in a couple of window stickers as well! Great for those who do not have the time to build the $20.95 kit.

ONLY

$29.95

Cat. LA-5960

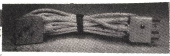
Kit version Cat. KJ-7000

$20.95

AT LAST! LOW COST TELEPHONE EXTENSION CORDS!

20 metre extension cord

Cat. YT-6014 **$24.95**

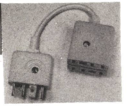


10 metre extension cord

Cat. YT-6012 **$19.95**

5 metre extension cord

Cat. YT-6010 **$14.95**



Telephone socket double adaptor

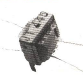
Cat. YT-6020 **$19.95**

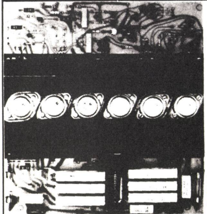
SCOOP PURCHASE!!

600 ohm line transformers slashed!

Another amazing below-cost buy. An Austral made chassis mount 600 to 600 ohm line isolat (or matching) transformer at a bargain price! B primary and secondary windings are an identi 600 ohms. The transformer measures 27(W)x20(x21(H)mm & features a grain-oriented silicon st for Hi Fi. There is no doubt that the unit would p line level, even +4dBm without trouble. Proba more. We have nearly 1½ thousand of them & th are offered on a first come, first served basis. Pri include tax. Cat. MT-4725

1-9 $2.95 ea: 10-24 $2.50 ea: 25+ $2.25 ea





300 WATTS OF MUSIC POWER!

Limited Stock Be Quick
(Kit Form)

For professional sound reinforcement, musician or home hi-fi, this one really delivers the power. A superbly designed power amp module that only needs a simple power supply, case, connectors and hardware to be up and running - at a fraction of the price of commercial units. See EA June 1980.

This kit includes all parts to build the module. Additional kits below provide the power supply and speaker protector. Team this with one of our 19" rack cases, a Sprite fan and some hardware, and you've got a high performance 300W mono amp ideal for any use. Specs are: Output power 300W rms into 4 ohms (200W into 8 ohms) - Frequency response 20Hz - 20kHz - 1dB - Hum and noise 95dB below 100W - Distortion below 0.2% at full output.

Module Kit complete	Cat. KA-1115	**$89.95**
Power Supply/Transformer	Cat. KA-1116	**$69.95**
Speaker Protector	Cat. KA-1117	**$12.95**

12/230V - 300W INVERTER

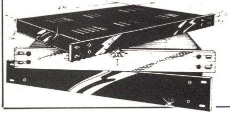
This unit provides up to 300VA of power at 235V from a ordinary car battery. It is ideal as a standby AC power supply The output is voltage regulated, gives a precise 50Hz an has current limiting with ultimate thermal shutdown.

The Jaycar kit features quality conservatively rated components and is complete down to the case and front panel.

Cat. KA-1114

REF: EA JUNE 1982

$19



RACK CABINETS

Beautifully crafted all Aluminium rack cabinets with top and bottom removable panels. Plain or black finish. Ventilated lid. Deluxe brushed anodised front panel. Supplied in flat pack but takes only minutes to put together. Dimensions conform to International Standard.

Cat. No.	Finish	Price 1-4	Price 5 up	Front panel ht.
HB-5411	Natural	$45.00	$42.50	44mm
HB-5413	Natural	$55.00	$52.50	44
HB-5415	Natural	$59.95	$55.00	88
HB-5410	Black	$45.00	$42.50	88
HB-5412	Black	$55.00	$52.50	132
HB-5414	Black	$59.95	$55.00	132

WAREHOUSE MOVING FROM OCT 1st TO 7/9 RAWSON ST. AUBURN 2144

SENSATIONAL!

W COST RECORD PLAYER KIT

f: ETI September 1984 (ETI 442)

he lowest price **TRUE** Hi Fi system that we have en!! Around 20 WRMS per channel with separate eble, Balance and volume controls. Around 20 w er channel into 8 ohms!
plifier unit **INCLUDES** power supply, all controls, RCA input sockets, speaker connectors, front nains cord etc.
te instructions (as per ETI article) are provided as plans for the turntable/amp cabinet.

AB THIS FANTASTIC KIT

FOR ONLY $59.95
E-4683

IAL HI FI BELT DRIVE TURNTABLE to used in the original ETI article - (see details of t in our other ads in this magazine)

A-0290

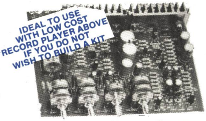
ONLY $29.95

SPECIAL LOW COST HI FI SPEAKERS TO SUIT - 6" woofer/midrange unit with curvelinear cone. Ideal for the ETI 442 amp project! (The voice coil has a 4 ohm impedance which is O.K.)
Cat AS-3011

ONLY $6.95 EACH!!

HI FI TWEETER to suit (no x'over required)
Cat CT-1910 ONLY $9.95

If you want the extra bass of an 8" speaker, we have an 8" twin cone unit for only **$19.95 Cat CE-2330**



Cat. AA-0300

30W + 30W STEREO PREAMPLIFIER

★ **Fully built and tested** ★ **Separate Bass, Treble, Balance and Volume controls** ★ **Less than 0.1% distortion** ★ **Mic, Phono and Aux inputs (line)** ★ **Power supply components on board.**

Back at last! No hassle amplifiers. Just connect a transformer, speakers a signal and you're away!

STAGGERING VALUE

ONLY $34.95

SPECIAL "PACKAGE DEAL" OFFER

Make further savings if you buy the lot.

ETI 442 AMP KIT KE-4683	**$59.95**
BELT DRIVE T/T AA-02900	**$29.95**
2x6" SPEAKERS AS-3011 ...	**$13.90**
2xTWEETERS CT-1910	**$19.90**
TOTAL	**$123.70**

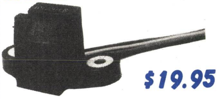
SPECIAL INTRODUCTORY PACKAGE

ONLY $99.50
FOR ALL OF THE ABOVE!!

HEY! THAT'S NEARLY A 20% SAVING!!

NEW - Ref: EA September 1984
HALL EFFECT SWITCH
VANE INTERRUPTED

If you have a car that won't take the Jaycar KJ-6655 Hall Effect Kit (i.e. an Australian six or V8) this could be for you! It is the SIEMENS (German) made Hall Switch. It will operate from −30 to +130°C. A simple soft iron vane cut with appropriate slots will commutate the unit.
Cat HK-2101



$19.95

PCB to suit 84T19 $3.45

OLAR-POWERED OUSE NUMBER SIGN

amazing project! Display your house number **AT T AUTOMATICALLY** with high brightness LEDs! ternal electric power source is required. The unit rges itself from the sun during the day and dis- es at night. Because each house number and ation will be different, we are selling the parts ot a kit.

200mCd LEDs Cat ZD-1790
69¢ ea (1-9) 60¢ ea 10 or more
30° 78mA Solar Cell Cat ZM-9004
$3.25 ea (1-9) $2.95 ea 10 or more
($35.40 for the 12 sectors)
"Gates" 2.5 A.H. Gel Batteries Cat SB-2490
ONLY $9.95 each
PCB to suit Cat EE-7085 $4.95
Ref: EA September 1984

ONLY $89.50

DUAL TRACKING ±22V POWER SUPPLY

Cat. KA-1410
Ref: EA March 1982

This versatile dual polarity (dual tracking) power supply kit can provide up to ± 22 volts at up to 2 amps. In addition the supply features a fixed +5V at 0.9A output. The supply is completely protected against short circuits, overloads and thermal runaway.The kit comes complete with case,meter and front panel.

RANSISTOR ASSISTED GNITION

REF: EA JANUARY 1983

$35

Latest version of this fantastically popular kit! The Jaycar kit comes COMPLETE down to the plastic TO-3 transistor covers, genuine heatsink and diecast box - as used in the original EA unit.
Beware of flimsy kits that use sheetmetal boxes!
This kit is designed to be used with contact breaker points, if you want Hall-Effect breakerless option may we suggest the KA-1505 version of this kit shown elsewhere on this page.

Cat. KA-1506

ANSISTOR ASSISTED NITION HALL-EFFECT "BREAKERLESS" ERSION $36.95

REF: EA DECEMBER 1983

is virtually identical to the KA-1506 except that it s the interface electronics for the KJ-6655 Hall- riggerhead.
-1505

ELECTRIC FENCE

Ref: EA September 1982

s or battery powered,this electric fence oller is both inexpensive and versatile. It ld prove an adequate deterrent to all manner estock. Additionally, its operation conforms e relevant clauses of Australian standard). (Kit does not include automotive ignition which is required).

A-1109 **$15.00**

3-50V/5 AMP VARIABLE POWER SUPPLY $149

Ref: EA May/June 1983

A brand new efficient design provides regulated high power. It features state-of-the-art switchmode techniques, dual meters and continuous adjustment. All parts for the kit are provided including specified case, front panel and special meter scales.

Cat. KA-1520

This kit represents a massive saving over equivalent built units! ± 12 V add-on kit (refer EA July 1983)

Cat. KA-1521 **$14.95**

TOUCH LAMP DIMMER

Ref: EA April 1983

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You can turn lights on and off (AND DIM THEM!) with one touch! Uses high-tech Siemens IC. Features attractive HPM wallplate (supplied). The Jaycar kit contains ALL the necessary components including the small contact spring. Watch out for similar priced kits that don't.

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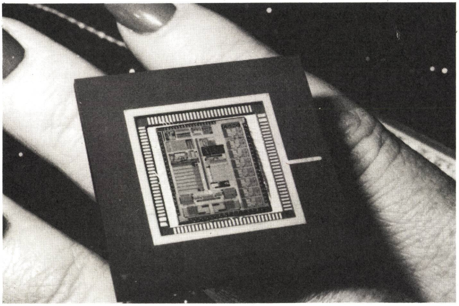
News Highlights



Austek:
Aussie microchip company

A new Australian computer company which aims to compete with specialist US chip manufacturers has been officially launched in Adelaide, supported by the Commonwealth Scientific and Industrial Research Organisation (CSIRO).

Austek Microsystems has a paid up capital of more than $US6.6 million, with investments attracted from US, British and Australian companies interested in the development of microchip design in Australia.

The first VLSI chip represented the culmination of an intensive three ye effort by a small design group, headed b Dr Craig Mudge. Computer aided desig (CAD) was used extensively througho the program. In fact, much of the group research was focused on th development of software to streamlin the design process. The sophisticate design system which emerged from th research, known as "SPRINT", w enable subsequent chip designs to b completed rapidly.

SPRINT employs a hierarchic approach to design in which the conce is progressively subdivided. Eventual the design reaches a point whe problems are reduced to a level whic can be comfortably managed by a individual. Designs representin solutions to these problems are store and then automatically assembled in an integrated chip design.

Each VLSI chip is in fact a number specialised "sub-chips" which a designed individually by specialists, an then linked to serve a unique functio Once a "sub-chip" has been developed what the designer considers an optimu state, its format can be stored on computer and then simply recalled serve as a component of another VL chip.

As a demonstration of the desig efficiency, the CSIRO group developed 102,000 transistor demonstration chi The IC, a voice recognition devic represents a design investment of fi man years. This compares with 150 ma years invested by US designers producing a 68,000 transisto microprocessor chip.

New FM and shortwave transmitters

Two new ABC FM stations — one each in Victoria and Western Australia — opened on 1 May 1984. They bring to 30 the number of stations in the ABC FM network, including seven in Victoria and five in Western Australia.

ABC FM Western Victoria will serve the western district, including Hamilton, Coleraine, Casterton, Edenhope and surrounding areas. The transmitter is at Mt. Dundas, at the same site as the TV transmitters for ABWV-5A (ABC) and BTV 6/10.

ABC FM Geraldton will serve Geraldton and surrounding areas. The transmitter is about 10km north-east of Geraldton (in the Moresby Ranges) at the same site as the TV transmitters for ABGW-6 (ABC) and GTW-11. It operates on 95.1MHz.

A new high-power shortwave transmitter at Carnarvon in Western Australia came on stream on Sunday 6th May and will give Radio Australia an additional broadcasting voice in its primary reception areas.

The 300kW transmitter is the second high-power facility at the Carnarvon transmitting station (the other is of 250kW). There is also a medium-powe transmitter of 100kW.

The $1.7 million transmitter will carr Radio Australia programs deep into Asi and the Indian sub-continent. It wi broadcast 24 hours a day, seven days week in several languages: English standard Chinese and Cantonese Vietnamese, Thai and French.

No bytes, comrade?

The United States, its 13 NATO allies and Japan have jointly agreed to impose broad, new export controls on the sale of small computers and sophisticated telephone equipment to Soviet bloc countries, according to Western diplomats.

The accord expands the existing NATO embargo on the sale of large, sophisticated computers to include smaller models that could have military applications.

This implies that many of the more expensive personal computers now available at retail outlets in the United States will be subject to NATO export controls in future.

The agreement completes the first major updating of Western restrictions on the sale of computers to Eastern Europe and China since the present computer embargo list was drawn up in 1976. Since that time, many important developments have occured — particularly in the field of personal computers.

60,000 telephone lines to Melbourne

Copper cables are out—optical fibres are in!

Telecom and AWA have announced the introduction of optical fibre technology to the Australian telephone system. Optical fibres manufactured by AWA will form part of new telecommunications links for much of the future communications between the nation's exchanges, and current commerical and domestic telephone users.

The first commerical installation of AWA optical fibres has been made between the Telecom radio tower in the Sydney suburb of Waverley and a central trunk exchange at Haymarket, a distance of some 7 kilometres. Fibres in this cable have been spliced and the initial system was to be fully operational by the end of July. Each individual fibre will be capable of carrying digital traffic at 140Mbits/s, corresponding to 1920 individual telephone channels.

The optical fibres are manufactured by AWA at its North Ryde facility in Sydney. At this plant AWA has been active in the optical fibre communications field for a long time, having initiated local research and development in 1972.

Currently, the company is increasing its optical fibre manufacturing capacity to meet the demands initiated by Telecom and other organisations, including railway and electricity authorities.

Optical fibres for the Waverley — Haymarket link have attenuation of 2.8 decibels per kilometre at 850 nanometres and a bandwidth in excess of 600MHz.

On a longer term basis, Telecom has announced that planning is well advanced for an optical fibre telecommunications cable to be laid between Melbourne and Sydney during the next two years, providing up to an additional 60,000 voice channels. It is intended that the new cable be ready for service by January 1988 — Australia's Bicentennial Anniversary.

The project is expected to cost more than $40 million, It will be a digital system and will complement the present broadband systems operating between the two cities. Survey parties have begun working along the route which would follow generally the path of the existing coaxial system.

Where practicable, existing above ground repeater stations will be used for the new cable but, because repeaters are not needed as frequently as with the present coaxial cable, only every third repeater shelter will be used in the new system. The optical fibre cable will contain 30 fibres giving it 60,000 voice channels or a combination of voice, data and television traffic at the one time. The present coaxial cable provides facilities for only 9,000 voice channels.

Trial satellite link for Antarctic base

A satellite communications earth station was set up at Mawson recently to assess the potential of satellite communications to meet future needs.

An investigation by the Antarctic Division has shown that existing communications' networks between Australia and Antarctica are inadequate and unreliable.

At present, communications between Australia, her Antarctic stations and expedition ships at sea, use high frequency radio links. These provide the sole means of communication, and are often severely affected by disturbances in the Earth's ionosphere.

According to Antarctic Division communications engineer, Sjoerd Jongens, satellite communications provide the greatest potential for improving Antarctic communications.

In order to evaluate satellite communications, the Antarctic Division has decided to purchase an Inmarsat ground station.

The Inmarsat system has three satellites in geostationary orbit 36,000km above the equator over the Atlantic, Indian and Pacific Oceans.

Mawson will use the Indian Ocean satellite, which will be some 13° above the horizon almost due north of the station.

This satellite's control stations are at Eik in Norway and Yamaguchi in southern Japan. Communications traffic from Mawson will travel to the satellite, down to the Japanese station, then to Australia via either an undersea cable, or the Intelsat satellite system to a ground station in Ceduna, South Australia.

Inmarsat stations are small and compact, being designed primarily for use on ships. The international Inmarsat council has given permission for what is normally a ship based system to be used at Mawson for the trials.

News Highlights

Data storage on compact disc

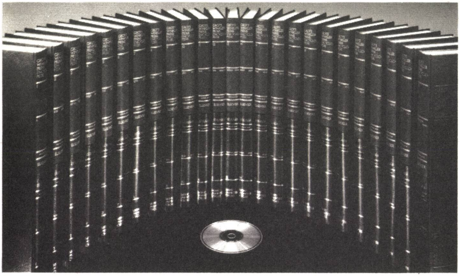
The Compact Disc, widely accepted as a music carrier of the highest quality, may well acquire another, completely different function: that of storage medium for computer data and programs.

This will be made possible by the "CD-ROM" where information is permanently stored so that it can be read out whenever required. The very large storage capacity of a CD-ROM disc — equivalent to around 150,000 document pages, for example — and its ability to be duplicated relatively cheaply, make it an ideal carrier for large volumes of information such as encyclopaedias.

This information will be read out from the disc by a special form of Compact Disc player connected to a home computer.

A further advantage of Compact Disc for this application is the disc's high degree of resistance to wear and accidental damage. The stored data is therefore very secure.

Under the continuing CD-ROM development program Philips has recently concluded an agreement with Sony about the format under which data will be stored.



Destroyer simulator for RAN

Major sections of a computerised bridge simulator, which enables Royal Australian Navy officers to control a destroyer without stepping off dry land, have been successfully designed, assembled, and tested by Computer Sciences of Australia Pty Ltd, (CSA) of St Leonards, NSW.

The equipment is now being installed by CSA at HMAS Watson in Sydney and is expected to be ready for use by the RAN in April next year

Using the simulator, junior officers will be taught to control a destroyer in completely realistic conditions without the cost and danger associated with taking a ship to sea. Computer generated scenery may be of a rough sea, of a harbour, or of a foggy day with extremely poor visibility and the bridge is made to roll and vibrate in keeping with the conditions.

The computer system monitors the instruments on the bridge such as the wheel, the speed indicator, engine controls, and the compass. It then relays the information to another computer which makes the simulated destroyer react in exactly the same way it would if it were at sea.

By medium of a computer controlled hydraulic motion base, which is also fitted with a vibration motor and pads, the bridge will physically react to extreme situations such as those caused by incorrect commands to propulsion and steering systems or by faulty navigation leading to running the ship aground.

The simulator is extremely flexible in that all types of Australian destroyers (destroyer escort, guided missile destroyer and frigate) can be simulated.

Business briefs

Fairchild Australia Pty Ltd will be giving a seminar on Charge Coupled Devices (CCD) at the EASA exhibition in Adelaide on Oct. 17th 1984. The seminar will be given by Mr Don Lake who is the Marketing Manager of Fairchild CCD Imaging Division in Palo Alto, California.

Mr Lake, who holds a BSEE and a Masters, has spent 20 years performing LSI and VLSI research and development. Recently he has been working on VLSI implementation of image acquisition and image processing.

The seminar will give an introduction to CCD technology, and cover the following subjects: (1) introduction to CCD technology; (2) linear image sensors; (3) monolithic colour linear sensors; (4) area image sensors; (5) advantages of CCD technology for image acquisition; (6) using cameras rather than imagers; (7) using imagers rather than cameras; (8) camera construction; (9) applications of line scan cameras; (10) applications of matrix cameras.

Those wishing to attend the seminar or anyone who would like more information should contact Mr Robert Ross at Fairchild Australia, Melbourne, on (03) 877 5444 or Mr Robert Crabbe at Protronics, Adelaide, on (08) 212 3111.

Labtam International Pty Ltd is presently negotiating with an economic and trade delegation from the People's Republic of China.

Negotiations included the intial development of technology to computerise weighing systems for conveyor process line manufacture in the Anhui Province.

The $A1.68M initial project is scheduled to commence within the next two months at Labtam's Braeside plant.

The Australian School of Electronics has moved to 116-120 Hawthorn Rd, Caulfield Nth, Melbourne 3161. The PO box and phone number are unchanged.

Promark Electronics recently signed a distribution agreement with Varitronic Limited for the marketing of liquid crystal displays and intelligent dot matrix modules.

Promark has also concluded an agreement with Tideland Energy Pty Ltd to distribute the extensive range of solar electric panels and modules made in Australia by Tideland.

at the leading edge

ELECTROLUMINESCENT DISPLAYS SET TO CHALLENGE CRTS

A long awaited lightweight, bright, flat screen display is now in volume production at **Sharp Corporation.** Four units make up a series of various sized low voltage, high resolution readouts the largest of which will display 25 lines of 80 characters on a **640 x 200** dot matrix.

Graphics and alpha-numeric interfaces are also provided by Sharp.

EL Displays are suited to portable, airborne, industrial and medical applications where high visibility, low voltage and ruggedness are paramount.

IBM®-XT COMPATIBLE HARD DISK CONTROLLER

Targetted at **Big Blues'** offspring and their workalikes **Western Digitals'** WD 1002-WX2 ushers in yet another series of board level controllers. Designed to plug straight into the expansion slots of the IBM®-XT and the PC the **WX2** may be tailored to work with other host processors.

Software drivers reside in PROM offering a high degree of flexibility to systems integrators.

Up to two ST506 interface standard drives may be daisy chained via the on board 34 way connector.

WANGTEK STREAMING TAPE DRIVES BACK UP 60MBYTE

As 5¼″ Winchesters push their capacities over the 100 Mbyte mark effective and rapid archiving becomes absolutely essential. **Wangtek Series 5000** drives condense the capabilities of a **20** to **60 Mbyte** streaming ¼″ cartridge tape drive into the same space as a half height mini-floppy disk drive. Control electronics to **QIC-02/24** standard may be mounted separately or in a full height configuration which matches the full height 5¼″ **Vertex** drives in the 50 Mbyte and up class.

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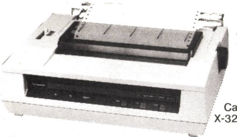
NEW

Panasonic 120 CPS Dot Matrix Printer


Cat X-3260

Compact, high performance unit - quality printing in various formats, including proportional spacing & graphics. A sturdy no-nonsense printer that will work hard all day, every day.

Recommended Retail was $975
Save $380. Our price **$595!**

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2 Disks for the price of one from XIDEX! (5¼" Floppies)

See coupon in most computer magazines plus EA & ETI. Don't miss out.

Last chance – closes 31st October.

Incredible!

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$99
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What a saving! Current catalogue price $169 ... now an amazing $99.00!!! But hurry - limited stocks at this crazy, crazy price.

With full range of accessories available and programs to suit every purpose you can't go past the fantastic VZ-200!

OVER 25,000 SOLD!

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- 16K Expansion module $79.00
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- **4 Program Pack Special**
  3 different sorts to choose from, each with 4 programs. Educational (X-7293), Financial (X-7292), Entertainment (X-7291). Separately $50
  Now only $19.95

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Purchase the VZ 200, the VZ Datasette, the 16k Expansion module and your choice of two 4 program packs for

JUST **$229** USUALLY $287, SAVE 20%: $58!!
or $34 deposit and $3.00 per week over 24 months.

See insert for store addresses

Dick Smith Electronics Pty Ltd

COMPUTERSTOP™

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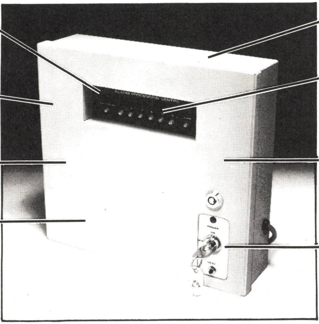
Save $ $ $ on professional quality security!

Homes... offices... factories... now you too can have a fully professional quality security system at a fraction of the price you'd expect. Yes: a multi sector, multi function alarm system as used in banks, offices, warehouses, stores, etc. can be yours with the all-new

DICK SMITH ELECTRONICS
Security Centre



- Window shows all sector status by LED indicators: you can tell at a glance what's happening where!
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- Inbuilt mains power supply with provision for either dry or rechargable back-up battery.
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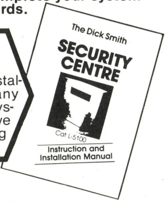
EXCLUSIVE

Especially written 16 page installation/instruction manual: any handyman could install this system — and you'll know you've saved hundreds of dollars doing it yourself!



The Dick Smith SECURITY CENTRE

Cat L-5100

Instruction and Installation Manual

See insert for store addresses

ONLY FROM

DICK SMITH ELECTRONICS PTY LTD

A709M

Letters to the editor

Applause for August editorial

I must applaud your August editorial and its reflections on a tertiary system that produces catalog engineers.

As an electronics hobbyist, I have built many of your audio projects — not from kits, but by etching my own boards and collecting components individually. I have also completed your Dream computer. All my projects worked — not always at switch-on, but eventually after close scrutiny of my work and assistance from other hobbyists.

In my occupation, I meet many engineers, all of whom are paid under the relevant award. Take two young engineers who work in my office. When I was having teething trouble with the Dream and suspected a fouled address or data line to the 2708 EPROM, I sought assistance from one of them.

His reply really set me back — "I have never heard of that device but you should be able to find the manufacturer's data". Further, he had no idea as to what symptoms could be expected from a corrupted line.

I decided to do a little survey on the three young engineers employed in my division. Result: none of them owned a soldering iron and only one of them had ever built any electronic device (your transistor ignition). This did not work and was subsequently discarded without any attempt at troubleshooting.

Later, my company purchased a robot to apply material in a production process. One of the engineers was put in charge of the project for its first trial. I heard on the grapevine that this machine was throwing material in all directions, supposedly due to a problem with the program.

Knowing that the machine held its program in EPROM, I approached one of the engineers concerned to enquire about the type of microprocessor used. He replied "I don't know anything about the guts of the thing but I do know the representative's phone number. He comes and changes the boards when we have a problem".

Such is the interest and motivation of the electronics engineers in my industry. I sometimes wonder if they would have degrees in animal husbandry if that had been fashionable at the time they applied for university entry.

I concur fully with your remarks an
am very proud to proclaim myself
humble hobbyist. At least I take the tim
to find out what's "under th
bonnet"

Name and address supplie
but withheld by reques

Hard sell and emotional innuendo

Welcome to the world of "hard sell
and emotional innuendo. Your editori
in the August issue would lead one t
believe that the circulation of you
publication is on the decline and that yo
are attempting to drum up more sal
from engineers who want to keep abrea
of modern technology. The questio
remains — "who the hell do you thin
you are?"

How dare you suggest that a
engineer who does not read you
publication regularly and does not kno
how a superheterodyne receiver works
not worthy of his title? You obviousl
have no idea of what it means to be a
engineer.

In the four years that it takes t
obtain an engineering degree (electrica
or electronic) an astounding number o
topics and subjects must be learnt, and i
most cases an examination in eac
subject must be passed. The basic idea i
not to memorise everything but to gai
an understanding which will then aid th

Five million Betacords

I read with concern your editorial comment titled "VHS has won the battle against Beta" in the July issue of *Electronics Australia.*

When three of Japan's largest manufacturers of domestic electronics are producing and marketing Beta format video cassette recorders, I am amazed at such an irresponsible and ill-informed comment. Sanyo Japan has recently produced its 5 millionth Betacord video cassette recorder and is to release its Beta Hifi machines.

I am equally amazed at your presumptuous comment in light of the fact that Sanyo has (and is spending) thousands of dollars on promotional activity for Beta format machines — surely this cannot be interpreted as "giving up the race"?

Sanyo has, and will continue to promote Beta format machines, as we firmly believe there will always be a market for a superior format of video cassette recorders and equipment, including the revolutionary Betamovie which has also been aggressively promoted.

In the United States, general consensus within the industry confirms Bata's share of over 40 percent. This remarkable resurgence has been ascribed to intense public interest in products such as Betamovie and Beta Hifi.

In Japan, the latest reports indicate Beta currently has a 50 percent share with some volume outlets reporting Beta sales as high as 55 percent.

Our commitment to Beta is also reflected in the continuous release of new models, including our two most recent releases — the VTC-M20 and VTC-M30.

Sanyo does not recognise any "victory" by the VHS format. Simply because Beta machines have been made available to the public at an attractive price is no reason to make any incorrect and misleading assumptions. The fact is, Sanyo and other Beta manufacturers have brought the enjoyment of supe
video entertainment within the reac
people with limited budgets. We
continue to do so.

Your misinformed comments
cause concern to those people who
or are intending to purchase a Beta vi
cassette recorder. If you wish
maintain the credibility of what has b
a respected publication, I suggest
pass on the correct information to y
readers as a matter of urgency.

Mitch Law
Australian Marketing Mana
Sanyo Australia Pty

● *We do not consider our comm*
misinformed or irresponsible. Nor do
agree with your figures on Beta's ma
penetration in Japan. Our informa
indicates that is closer to 30%. (Ed.)

Beta sales increase in Japan, USA

I am writing in reply to your edito
in the June *EA* issue concerning V
versus Beta. Being the owner o

working engineer to make intelligent decisions, or to know enough about various subjects to make it possible to design a circuit/motor/device/control system/etc by referring to textbooks and data books. The graduate engineer begins to specialise and focus on a certain field of engineering once he begins to work in that field.

The only engineer who will know how a superheterodyne receiver works will be one who either works in the field of radio communications or who has a hobby which would lead him to find out. Furthermore, knowing how a superheterodyne receiver works has absolutely nothing to do with one's competence as an engineer unless one's particular field of work requires such knowledge.

It also appears that you have a rather inflated opinion of your publication. You claim that anyone who has been a regular reader of your publication over the last few years would have little difficulty in answering the five questions. This is simply not the case. I asked a recently graduated Chemical Engineer (ie, obviously reasonably intelligent), who has a strong interest in electronics and who also buys and reads *Electronics Australia* every month, if he could have answered the questions. By your criteria it turned out that he is incompetent and not worthy of his title (fortunately I was able to dissuade him from tearing up his worthless degree). I also doubt the value of your publication as a guide to the latest technology as it relates to engineering. I don't call a "Guitar Sustainer" or an "Ultrasonic Movement Detector" the latest technology.

Perhaps you should consult with the CIA and ask them to keep a list of all practising engineers who don't read *Electronics Australia* and to circulate it to all prospective employers, and perhaps you, dear editor, should get sunglasses and a corn-cob pipe and walk around saying "better read than not read" and paint ugly emotional pictures of what the world would be like if nobody read *Electronics Australia.*

I should mention that one good thing has come from your editorial. It prompted me to ask myself, "why do I buy this magazine?". Upon analysing it more closely I realised that I'm not really interested in VCRs or television or radio, so I couldn't answer the question. Basically what I'm saying is that your circulation has just dropped by one and you can put me at the top of your CIA list. If you like, you can have the name of my employer and let him know, but I'm quite sure that he is satisfied with my level of competence.

Holger Lubotzki,
Semaphore South, SA.

PS. The next time I see one of my old university lecturers I must ask him to consider making *Electronics Australia* a compulsory part of the curriculum for electrical and electronic engineering courses.

Computer club

I am attempting to form a Victorian Wizzard users' group of owners of Dick Smith Wizzard and Funvision computers. Members will receive a newsletter (Wizzdom). I intend to hold a meeting in early September.

I can be contacted at home by phone or letter as shown below.

Barry L. Klein,
24 Russell Street,
Bulleen, Vic 3105.
(03) 850 7275 ah.

Engineers should read editorial

Thank you for an excellent Editorial in the August issue. Although I am sub-professional, I think that your article should be compulsory reading for many of our "engineers", for many of them are as you so aptly described in the article. A shame, but a fact of life!

Please thank Mr. Williams for his review on the Brother EP-44. I had bought during July, just before *EA* hit the streets. However, I am quite happy with the EP-44, as it makes a very quiet terminal. I have been reading the magazine since back when it was still known as R, T&H. Keep up the good work.

C.D. Reynolds,
Paddington, NSW.

Betamax machine I have also read statements from the manufacturers saying they will not be stopping production of these machines.

I have enclosed a cutting from the "Sydney Morning Herald" supplement, "The Guide", June 25, 1984, as per sales increase in Beta video players, in Japan and the USA.

In conclusion, I know of some people who have bought Beta machines as a second unit to their VHS players.

Name and address supplied
but withheld by request.

Beta: around for some time yet

Why has Leo Simpson made such a fuss about the so-called "demise" of the Beta format? Was there the same fuss made when several other video formats disappeared, for example, Akai, Philips, Technicolor, etc? Are there other forces behind these outlandish statements?

The facts are that both Beta and VHS formats will be around for a long time to come. It would have been far easier if there had been the one ½-inch format; as with the ¾-inch and 1-inch commercial video systems developed by Sony.

As everybody knows, the sound of ½-inch format video is mediocre. Sony developed a hifi sound system as well as the standard sound track. Because of Sony's hi-tech development in this field, VHS manufacturers were forced to follow. In Australia both formats will have hifi sound and stereo tuners which will be released simultaneously.

The mono models obviously cannot compete with the new systems and naturally have been discounted to sell quickly. Look at the present confusion regarding stereo sound in the VHS format.

The so-called VHS explosion in sales is due to the proliferation of models. There are seven manufacturers of VHS video recorders distributed in Australia, but they cover over 20 popular brand names. This system of cloning does not apply to the seven Beta manufacturers who only produce their video brand names.

Naturally, with more popular brand VHS models for public consumption, the video rental shops, which come and go due to economic circumstances, sometimes cannot carry both formats.

Sony makes blank tape for all audio and video formats and has been making VHS tapes for almost two years. RCA previously only made VHS videotape but now makes Beta videotape because of customer demand.

Given all things equal — monitor, video etc, "Blind Freddy" could see the difference between Beta and VHS.

Gradually, the poor, confused public will wake up to the misleading information. If readers can't rely on the impartiality of information in publications such as *Electronics Australia* what are they to do to gain the necessary knowledge for their electronic interests?

C. Couglan,
Burwood, NSW.

A typical piece of amateur commercial equipment. The Yaesu FT-757GX is a MF/HF transceiver covering all amateur bands from 1.8 to 30MHz. The transmitter is rated at 100W in SSB, CW, and FM, and the receiver gives continuous coverage. (Photo from Dick Smith Electronics.)

Introduction to

What is amateur radio and how does one set about becoming involved in it? This article sets out to answer these questions. If you nurse a secret longing to join the amateur ranks this might just be the catalyst to get you going.

by PHILIP WATSON VK2ZPW

Most readers will have some knowledge of amateur radio, at least in broad terms, but would undoubtedly be rather vague when it comes to precise details. So let's see if we can fill in the gaps.

The question, "what is amateur radio?" is almost as hard to answer as the "how long is a piece of string?" conundrum because it is many things to many people; each amateur has his own ideas as to what particular facet of the hobby appeals to him, and why.

But there is also a lot of common ground, so let's concentrate on that first. Fairly obviously, the basic incentive is simply to communicate, by radio, with other amateurs, whether they be on the other side of town, or on the other side of the world. Both can provide an equal amount of satisfaction when they succeed in spite of all the odds being against them.

Perhaps it might help at this stage to look at the official definition of the "Amateur Service" as designated by the Department of Communications (DOC), the Federal Government department which issues amateur licences. They say, " 'Amateur Service' means a service of self-training, intercommunication and technical investigations carried on by amateurs, that is, duly authorised persons interested in radio technique solely with a personal aim and without pecuniary interest."

In spite of the cold official jargon, that sums the situation up very effectively. The terms "self-training", "technical investigations" and "radio technique" give a good idea of how the authorities view the amateur scene.

How it started

Some of the history of the amateur service may also help set the scene. It all started in the very early days of radio when few, if any, regulations existed. This was in the early 1900s, in the days of spark transmitters, crystal detectors, and coherers. It was more or less open slather and hobbyists were quick to embrace the new science, first with home-made receivers with which they listened to the Morse code signals from ships, and then transmitters with which they could communicate with the ships and other enthusiasts.

With more and more professional use of radio by ships, the armed forces, and commercial telegraph companies, competition for space in the spectrum became acute. Chaos threatened until governments realised the need for appropriate regulations. And, as can be imagined, amateurs were at the bottom of the priority list.

But they weren't wiped out completely. Most countries recognised that would-be experimenters had a legitimate need for some spectrum space in which to pursue their their hobby and, hopefully, contribute something to the new science. So they were permitted to continue, but with quite severe restrictions on power, frequencies, etc, aimed at avoiding interference with professional services.

This was the situation up until World War I, when all amateur services were shut down. They were reinstated when hostilities ceased, though not immediately, and not without a struggle in some countries. The official attitude to radio technology in those days was that the long waves, around 600 metres (500kHz), and longer, were the only usable ones for long distance communication. Everything below (shorter than) 200 metres (1500kHz) was regarded as worthless.

Thus it was that amateurs were relegated to this part of the spectrum, below 200 metres, on the basis that they wouldn't do any harm there, but wouldn't do any good either. It is now history that this move created one of the biggest upsets in professional theory in the history of radio. Amateurs quickly showed that they could do at least as well

Another, rather more elaborate, MF/HF transceiver, the Kenwood TS-430S. Coverage from 1.8 to 30MHz, continuous receiver coverage, transmitter power up to 250W PEP (SSB), plus a host of operating features. (Photo from Trio-Kenwood (Aust) Pty Ltd.)

amateur radio

If you live in the Sydney area and would like to see amateur radio in operation, pay a visit to the Museum of Applied Arts and Sciences, Mary Ann St, Ultimo, where station VK2BQK operates at weekends. A wide range of modern and historical amateur equipment is on display and operators, when present, can answer questions.

as, and often a lot better than, the professionals with their long wave systems, and with only a fraction of the power.

As the news spread the professionals were quick to jump on the band waggon, and moved down among the amateurs. Chaos threatened once more, until new agreements and regulations could be formulated. The result was the basis of the amateur spectrum allocations we have today.

This arrangement is that the Amateur Service is allocated a tiny slice of working space at regular intervals throughout the radio spectrum. These allocations are often on a two-to-one basis, ie, each allocation is approximately twice the previous frequency. In other cases it may be nearer three-to-one.

The broad reasoning behind this system is that it provides amateur bands at representative points right through the spectrum, each band encompassing a different technology, different hardware, and different propagation characteristics. So, regardless of what characteristics an amateur wishes to investigate, there is a place in the spectrum for him to do it (see accompanying list of amateur bands.)

The amateur concept is truly international. All but a very few countries, mainly of the "third world" or "emerging" variety, embrace the amateur concept. The Amateur Service is recognised by the International Telecommunications Union (ITU), the international body which co-ordinates all aspects of international radio communication, mostly at professional level.

Agreements reached at ITU conferences, held in Geneva every few years, are binding on the signatory countries, such as Australia, and each country's administratory body, such as DOC, is charged with the job of seeing that these agreements are adhered to. For this reason, authorities such as DOC cannot make major changes to the regulations on their own initiative; they have to follow the international rules.

The amateur licence

As already implied, the would-be experimenter needs to hold an appropriate licence before he can operate on any of the amateur bands. The amateur licence is unique in many

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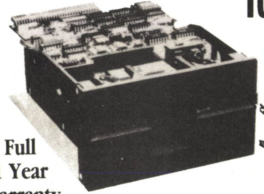

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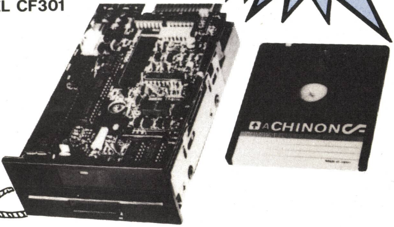

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For those who wish to expand their practical experience this Heathkit HW5400 HF transceiver is available in kit form. Covering from 3.5 to 30MHz, it provides both phone (SSB) and CW modes. (Photo from Warburton Franki.)

respects. For one thing it cannot be bought; it has to be earned. Licences for other services, such as radio and TV stations, mobile radio systems as used by public utilities, private companies, etc, are issued against the equipment, on the basis that it is type approved and suitable for use by unskilled persons, or under the supervision of qualified engineers.

The issue of such licences is largely a matter of formality once the need for the particular service has been established. The amateur licence is issued only after the applicant has shown, by passing an examination, that he has the necessary technical and other qualifications. And it is issued to the individual, rather than the equipment.

The reasoning here is that, once the applicant has shown that he has the necessary qualifications, he should be free to use any equipment he likes, provided only that it meets the broad requirements as set down for the amateur bands. The amateur can build his own equipment, modify or add to commercial equipment, use it with any kind of ancilliary devices such as antennas, microphones, tone generators etc. In short, he is free to experiment as he wishes, provided only that he works within the broad constraints of his licence.

At one time, most countries issued only one amateur licence, and which covered all the privileges available in that country. In more recent years many countries, including Australia, have introduced a range of licences, each one conferring greater privileges than the one below it.

Thus, the only amateur licence available in Australia until the 1950s was what is commonly referred to as the "Full Licence". This involved a quite stiff technical exam, a regulations exam covering the rules under which amateur stations must operate, and a Morse code test, sending and receiving, at (then) 15 words per minute.

The Morse code test is one of the requirements laid down by the ITU, but individual authorities can set their own standards within reason. On this basis the Australian test was changed, first to 12wpm and then to 10wpm, where it now stands. The maximum power (input to the final stage) allowed at that time was 25W, but has been progressively increased to 150W (400W PEP in the case of single sideband, or SSB.)

In 1953 the Australian authorities created the "Limited Licence". This abolished the Morse code test, but restricted the user to those amateur bands above 50MHz. This concession was on the basis that these frequencies were unlikely to be used internationally and therefore could be exempt from this requirement. The concession was, in itself, an ITU agreement, except that it specified only those bands above 144MHz.

In this respect the Australian authorities cheated a little, on the basis that Australia's isolation would make it unlikely that international contacts could be made on 52MHz. In the event this proved to be wrong; under favourable conditions contacts are possible with New Zealand, Japan and Russia. On the other hand the ITU agreement was later modified to include 50MHz.

The Limited Licence allowed many more enthusiasts to become amateurs, particularly those with engineering and technical background but who, for various reasons, found the Morse test too big a hurdle.

More recently still (1976) the authorities introduced the "Novice Licence". This involves a lower standard technical exam, a standard regulations exam, and 5wpm Morse test. Holders of this licence are restricted to portions only of the 3.5 to 3.8MHz band (3.525 to 3.625 MHz), the 21 to 21.45MHz band (21.125 to 21.2), and the 28 to 29.7MHz band (28.1 to 28.6). Power is restricted to 10W (30W PEP).

It is possible to upgrade from one licence to the next by sitting for the appropriate sections of the examination. Thus a limited licensee can upgrade to full status by taking the Morse test only. The novice would have to take both a new technical exam and Morse test.

Amateur activities

And what does amateur radio offer the enthusiast once he has obtained a licence? Or, putting it another way, what do amateurs do? Their most basic, and obvious, activity is simply to communicate with one another, but there is a good deal more to the amateur scene than that.

Basically amateurs are experimenters and there is plenty of scope for experimentation. A whole range of communication modes are available, though not all of them on all bands. There is a choice of Morse code (CW), radio teletype (RTTY), phone using AM, SSB or FM, facsimile (transmission of still pictures), slow-scan TV, and conventional TV in either monochrome or colour.

Each of these subjects is quite complex in its own way (yes, even the humble Morse transmission) and an amateur who decides to explore any one of them will find that there is tremendous amount to be learned. And, if he is of an inventive turn of mind, he may well develop circuits or techniques which will contribute significantly to the state of the art.

But whether he does or not he will undoubtedly benefit from what he learns. In fact, this is one of the most significant things about amateur radio; it provides a most powerful incentive to study and learn.

Further scope is provided by the various frequency bands available. No two are exactly the same in terms of propogation characteristics or the hardware needed to use them, and learning about this aspect alone is a significant challenge. At VHF and higher, particularly, the normally limited range is a challenge in itself, and some surprising records have been established by amateurs using simple equipment and a lot of patience.

Expanding the scope still further there are large scale group projects. Typical examples are Moon bounce, terrestrial repeaters, and even satellite repeaters. (Yes, amateurs usually have at least one satellite of their own in orbit.) Which

Introduction to amateur radio

brings us to another aspect of amateur radio. Amateur radio as it is today could not exist if it was composed simply of individual amateurs. Some form of representative and controlling body is essential.

Representative bodies

Amateurs in most countries have such a body. In the US it is the American Radio Relay League (ARRL), in Britain it is the Radio Society of Great Britain (RSGB), in New Zealand the Association of Radio Transmitters (NZART) and in Australia it is the Wireless Institute of Australia (WIA). These bodies take care of and co-ordinate those aspects of amateur radio which are beyond the scope of individuals. (The WIA, incidently, is the oldest such association in the world, having been formed in 1910.)

In particular they act as a mouthpiece for all the country's amateurs at both the local (DOC) and the international (ITU) level, protecting amateurs' privileges as they stand and seeking, where possible, to improve them. The WIA is an Australia-wide body, with Divisions in each state.

Further down the scale in the group activities are local clubs. These are usually affiliated with the WIA but otherwise operate as autonomous bodies. One of their major activities is the provision of terrestrial repeaters mentioned above. These operate mainly in the two-metre band (144-148MHz), but there are some in the six-metre band (52-54MHz) and in the 70cm band (420-450MHz). Establishing such a repeater can involve a club in several thousand dollars expenditure, plus a lot of voluntary labour.

Such repeaters are invariably located in elevated locations and greatly increase the range of communication, particularly from mobile and hand-held equipment. They are freely available to all amateurs, whether club members or not. At the time of writing there are some 10 repeaters in the Sydney area, plus a swag in country areas such that a travelling amateur would seldom be out of touch with at least one.

Another example of VHF equipment. This Yaesu FT-203R hand held unit weighs only 450g, covers 144 to 148MHz on FM, and radiates 2.5W. The range of sets like this is quite surprising under line-of-sight conditions. (Photo from Dick Smith Electronics.)

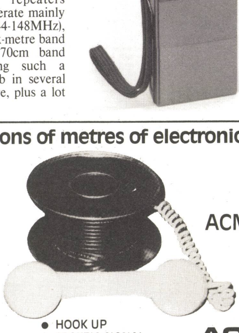
Satellite repeaters

Satellite repeaters are a much bigger, international, undertaking. An organisation called AMSAT, based in the US, is the central body, with representative groups in the major countries. As a result of this joint effort, 11 satellites have been launched so far, all carried free as "ballast" on NASA launch vehicles used to launch commercial satellites.

Not all these satellites were repeaters, the early ones being simply beacons to test feasibility. Some were lost when the launch vehicle failed to put them in correct orbit or ran amok on take off and had to be destroyed. On the other hand, some remained aloft and working for several years and provided invaluable experience for amateurs in space age technology.

Another group activity has a more serious role. Amateurs have always responded in times of national emergency; floods, bushfires, tornadoes, earthquakes, etc, when normal communications are usually disrupted. In the past, amateurs have often provided the only communication link in the initial stages, one of the early examples being the Napier earthquake disaster in New Zealand in the 1930s.

These days various professional emergency services have their own radio systems but, even so, when real disaster strikes there are seldom enough circuits and amateurs can still help. To provide a co-ordinated group, ready trained by means of numerous exercises, the WIA has created WICEN (Wirelesss Institute Civil Emergency Network). It is an Australia-wide organisation, but is normally administered at group level



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For the VHF enthusiast this Kenwood TR-7950 two metre transceiver is suitable for either station or mobile use. It covers from 144 to 148MHz in 5kHz steps, operates in the FM mode, and is rated at 50W. (Photo from Trio-Kenwood (Aust) Pty Ltd.)

often associated with local SES (State Emergency Services) and radio clubs.

Pervading all these amateur activities is the amateur's almost universal inclination to build electronic devices; to get down to basics with components, wire, printed boards, etc, attack them with a soldering iron and pliers, and make a working device for himself. It provides tremendous satisfaction, plus invaluable practical training.

At one time amateurs made the most of their own gear, both receivers and transmitters. These days commercial equipment has largely replaced the home constructor, being cheaper, smaller, and offering more facilities than most home constructors could hope to equal. Time alone would beat most.

But there is no shortage of things to build. Few commercial units have all the features the individual would like, and devising and building "add-on" units is a popular pastime. Antennas are another do-it-yourself subject; everyone has his own ideas about the "best" antenna. Power supplies, to power equipment designed for 12V car-battery operation, is a popular exercise, as are "after burners" — RF amplifiers to increase the power of a transmitter. The list is endless.

Amateur transmissions

And, on-air, what do amateurs actually achieve? What distances can they cover, and with what kind of reliability? For the holder of a full licence, the world is his oyster. With modern HF equipment, and particularly since the development of SSB, there is hardly a point on the globe which an amateur signal cannot reach.

Which is not to say that an amateur can walk into his shack (all amateur domiciles are "shacks"), switch on, and put in a call to Madagascar as easily as one would dial ISD. Not all bands are open to all parts of the world at all times. An experienced amateur who wants to contact a certain part of the world will have learned what band to use to suit the distance, the direction, the time of year, and the time of day, to name only the major factors. Acquiring such experience is what being an amateur is all about.

For the Limited Licensee, working above 50MHz, most contacts are essentially local, being restricted, at least in theory, to line-of-sight. But repeaters, high gain antennas, elevated operating sites, plus an element of luck, can work wonders, and many amateurs consistently work over hundreds of kilometres. And, when the six metre band (52-54MHz) opens, as it does about once a year in mid-summer, signals pour into Sydney from Queensland, South Australia, Tasmania and New Zealand.

AUSTRALIAN AMATEUR BANDS

MF
1.800 to 1.869MHz
HF
3.500 to 3.700MHz
3.794 to 3.800MHz
7.000 to 7.300MHz
10.100 to 10.150MHz
14.000 to 14.350MHz
18.068 to 18.168MHz
21.000 to 21.450MHz
24.890 to 24.990MHz
28.000 to 29.700MHz
VHF
50.00 to 52.00MHz
52.00 to 54.00MHz
144.00 to 148.00MHz
UHF
420.00 to 450.00MHz
576.00 to 585.000MHz
1240.00 to 1300.00MHz
2300.00 to 2450.00MHz
SHF
3300.00 to 3600.00MHz
5650.00 to 5850.00MHz
10000.00 to 10500.00MHz
24000.00 to 24250.00MHz
*Subject to the existence and operating times of channel 0 TV transmitters

This kind of thing happens less often on two metres (144-148MHz) but breakthroughs to New Zealand have occurred in recent years. Higher frequencies present an even greater challenge, but records running into thousands of kilometres have been established.

Another aspect of amateur radio, already mentioned briefly, is its international nature. Because an amateur in (say) Australia is likely to find himself in contact with another amateur in almost any country in the world, a code of ethics has evolved, quite informally, which is designed to encourage this social contact.

Amateur radio does not recognise any differences due to race, colour, country, religion, or social status, and discussion of such subjects, at anything more than the most superficial level, is taboo. The atmosphere is always informal, and normally on the equivalent of first name terms. King (yes, there is one) or commoner, their mutual interest is amateur radio and their latest achievement or new activity.

So what kind of people become amateurs? Contrary to what might be imagined, they are not all from the electronics industry, although these people probably constitute the larger proportion. The remainder come from all walks of life; clerks, doctors, shop assistants, clergymen, ambulance drivers, professional entertainers, policemen, politicians and housewives.

Handicapped persons also amount to a significant percentage of amateurs. Blind persons, often using specially developed or modified equipment, derive a lot of pleasure from building up a circle of friends, no further away than their microphone or key.

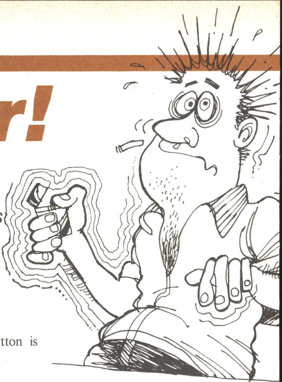
The same applies to persons confined to a wheelchair, or otherwise limited in mobility. And those with speech or severe hearing problems can often break down the barriers using Morse code, which they can handle on level terms with any other amateur.

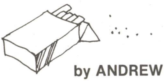
All of which adds up to a form of world wide free masonary which, in its own small way, has helped to break down many of the social, religious, and other barriers which have hampered understanding and acceptance of people whose ideas differ from our own.

Still interested in amateur radio after all that? Keen to get started? Watch out for the second part of this article in which we will get down to the nitty gritty of joining the amateur ranks; the various licence details, nature of the examinations, the kind of study course available, and the general procedures to be adopted.

The Stinger!

At last Electronics Australia presents an anti-smoking project. Dubbed "the stinger", and dressed up to look like a cigarette lighter, this project tackles the smoking problem on two fronts. Firstly, it won't light anything, and secondly it delivers a high voltage bite that the victim will long remember.





by ANDREW LEVIDO

The stinger is an appropriate name for this project. Disguised as a mild-mannered(?) cigarette lighter, it lies in wait for the unspecting smoker (or fiddler). When the button is pressed the victim receives a high voltage "bite". While totally harmless, it gives a large enough jolt to leave even the most thick-skinned individuals wondering what hit them.

This stinger was inspired by a commercial version which did the rounds of the offices in the building in which *Electronics Australia* is located. We had long held the theory that smokers are gullible people. (They have to be to believe the cigarette company propaganda), and from the reports we heard, those in our building were no exception.

When at last the device landed on the editor's desk he was quick to decide that, in the interests of community health, we had an obligation to describe such a device to our readers. While this device may not actually prevent any smokers from indulging, it will certainly act as a sharp reminder to them that their habit is not encouraged.

The stinger is very simple to build, and should not cost much, especially if the constructor uses his ingenuity in making the case from materials which he has at hand. This can be as simple or as sophisticated as you feel like making it, but remember that the key to getting people to use it lies in fooling them into believing that it is really a cigarette lighter.

Due to the nature of this project, finding someone silly enough to test it was quite a problem. Eventually we found a few specimens who fitted this description, and judging by their reaction it is a most successful project. Make sure you build the thing solidly though, because you will find that it hits the floor a very short time after the button is pressed.

How it works

A brief glance at the circuit diagram shows that there is not much to this project. If the second coil on the core is ignored for the moment, we are left with the circuit of an elementary electromagnetic buzzer. As we have devoted an entire article to the buzzer in a previous issue (April '83), only a short review of its operation will be given here.

The buzzer is simply a relay wired up so that it is operating in an astable mode. This means that when power is applied the relay will not be at rest in any state, but rather it will oscillate from one state to another. In order to understand how this happens, consider one cycle of the buzzer's operation.

When the switch is closed, current flows through the relay coil and sets up a magnetic field around the relay coil core. This field attracts the armature of the relay which is attached to the moveable switch contact. As this happens the circuit is broken and the magnetic field collapses rapidly.

When the field has reduced to a certain level the armature returns to its original position because of the return spring. The circuit is then complete again and the cycle repeats as long as the pushbutton is held closed.

The relay coil stores energy in the magnetic field. When this field collapses this energy must be dissipated in some way. To understand just what does happen to this energy it is necessary to introduce an important equation concerning inductance, $E = L\ di/dt$.

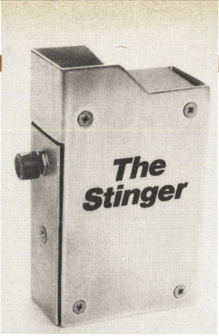
This equation gives the relationship between the voltage across, and the rate of change current through a coil. It states that the voltage across the coil is equal to the inductance of the coil (L) times the rate of change of current through the coil (di/dt).

When the relay contacts open, the current through the coil drops to zero very rapidly. This means that di/dt is very high, and a correspondingly high voltage is developed across the coil. This results in a spark across the relay contacts which is where the stored energy is dissipated. It is this high voltage, called the back-EMF (electromotive force), which gives this project its "teeth".

The need for a second coil stems from the conflicting requirements of low voltage operation, and high back-EMF. As we have seen, the back-EMF voltage is proportional to the inductance of the coil. Another equation, defining inductance in terms of the physical characteristics of the coil, is useful here, $L = N^2/R$.

This equation shows that inductance (L) is equal to the square of the number of turns (N) divided by the reluctance of the magnetic circuit (R). It is often convenient to think of reluctance as a type of magnetic resistance. Since the relay used has a fixed value of reluctance, the only parameter which we can easily vary is the number of turns.

Thus, for a high back-EMF we require a high inductance coil, and hence a large number of turns. However, if the relay is to operate from a single 1.5V cell, we



The "Stinger". Note the folded panel for the sides and the separate front panel.

require a low resistance winding, so that the maximum possible current will flow through the coil. This implies the use of few turns and thick wire.

The solution to this apparent dilemma is to use, as we have, two separate windings. One, with relatively few turns of reasonably thick wire provides the buzzer action, and the other, with many turns of fine wire develops the desired high back-EMF. In other words, we have produced a transformer which steps up the relatively low back-EMF produced by the primary (current) winding to produce a high voltage bite.

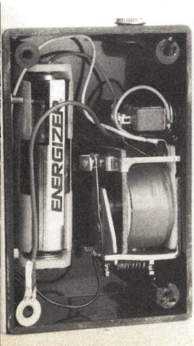
Just in case readers may be wondering whether the device is dangerous, we can say that it is not. We measured the secondary voltage at 300 volts peak-to-peak across a 10kΩ load.

Construction

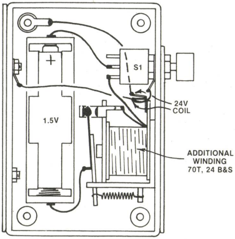
The key to the success of this project as a practical joke lies entirely in getting people to believe that it is a cigarette lighter. Some care must be taken in the construction then, because although the lighter only has to fool your victims long enough for them to press the button, people are highly suspicious creatures.

As mentioned earlier, a standard relay forms the basis of the works of this project. We used an Omron 24V relay for our prototype and this is the type we recommend. This relay is available from Dick Smith Electronics (Cat S-7014) for 50 cents. The existing 24V coil is used as the high voltage coil, and a new low voltage coil is wound over this to form the buzzer coil.

Before this new coil can be wound, the relay must be taken apart. This is done by first removing the spring, and then the armature, after the wire connecting it to the frame has been desoldered. If the rivetted portion which holds the relay core into the frame is then filed off, the rest of the relay should come apart.



Left: Interior view of the "Stinger". Compare with the wiring diagram below.



You are now ready to wind the new coil over the existing one. We used 70 turns of 0.5mm (24 B&S) enamelled copper wire, but neither the wire gauge nor the number of turns is critical. A few turns more or less, or a wire gauge either side of that which we used, should not make much difference. Leave about 50mm of wire at both ends for termination, and cover the new winding with a layer or two of insulation tape.

Reassemble the relay in the reverse order to disassembly, being careful that the core is seated well down into the chassis. The core is conveniently tapped to take a 3mm mounting screw which will also serve to hold the relay together permanently. Construction of the case is the next step.

We based our housing on the smallest sized zippy box, on which we mounted three aluminium panels to serve as the touch contacts. These panels also disguise the zippy box and contribute to the cigarette lighter illusion. The box is stood on end, the top and bottom becoming the sides, the long sides becoming the front and back, and the short sides becoming the top and bottom.

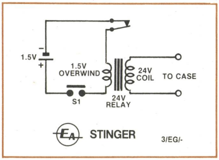
One panel folds around the two sides of the box and forms one electrode, while two smaller panels are attached to the front and back to form the other electrode. In this way it is almost impossible to pick up the lighter without bridging the two electrodes with your hand. The shape of these panels can be seen in the accompanying photographs.

The back and front panels are attached to the box first. One of these is held in place by the relay mounting screw and the pushbutton switch, and the other by machine screws and nuts. A solder tag is included under one of these nuts to make the connection to this panel. A wire soldered to the switch mounting washer provides the connection to the other panel.

The folded panel forms the lid, and is held in place by self tapping screws. Four of these go into the normal screw holes in the zippy box, and we included four more on the other side to make the lighter look symmetrical. Do not forget to include some kind of suitable orifice on the top, to simulate the jet where the "flame" is supposed to come out. We used a 3.5mm jack socket.

Once all the parts are installed in the case, they can be wired according to the diagram provided. We had difficulty locating a single AA cell holder, so we used a cut-down double cell holder. This was held in position in the case with double sided adhesive tape.

When the lighter is assembled it should be tested. The best way to do this is to get someone else to try it. If it is working it will make a buzzing noise, and the test subject will drop it very smartly. If they are willing to try it again, there is probably something wrong, with either the lighter or them.



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SPECIFICATION

- ★ Dimensions 330 (W) x 285 (D) x 60 (H) mm overall.
- ★ Platter Diameter 280 mm.
- ★ 2 speed 33 and 45 rpm.
- ★ Pick up Arm Counter balanced type with cueing facility.
- ★ Pick-up ceramic stereo with diamond stylus.
- ★ Turntable operation - auto stop, returns to rest automatically. Turntable chassis is sprung on all corners.
- ★ Output stereo RCA sockets provided.
- ★ Weight 1.5KG.

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CAT.A 0612 **$29.95**

240V VERSION (includes 12V adaptor)
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* * *

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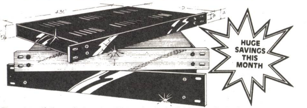

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H 0403	Natural	132	89	126	59.95	**54.00**
H 0411	Black	44	34	38	45.00	**39.00**
H 0412	Black	88	57	82	55.00	**49.00**
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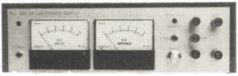

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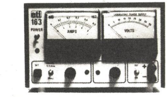

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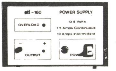

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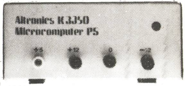

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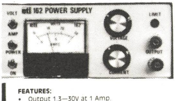

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- Regulation better than 0.2% from 0 to full load.

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Loudspeake

. . . A hifi hassl

On paper, the impedance rating of a loudspeaker system looks all very tidy and official: 4 ohms, 8 ohms, 15 ohms, etc. But don't take it too seriously; don't count on it. At best it's a rough guide; at worst, it can add up to a variety of hifi problems that have been around for the past 50 years.

by NEVILLE WILLIAMS

It is for this reason that engineers generally tend to avoid reference to loudspeaker "resistance", preferring the more factual term "impedance" or even "nominal impedance".

Virtually by definition, the impedance of a loudspeaker will not be a single, constant figure but will vary with frequency. It is something that loudspeaker (and amplifier) designers are stuck with, no matter how much they might wish it otherwise!

Back in the early '30s, "wireless" technicians were aware of these facts in a vague sort of way, assuming that the impedance of a loudspeaker would always be 20% or so higher than the measured resistance of the voice coil, by reason of its inductance. In fact, they relied on this "rule of thumb" to classify loudspeakers that had lost their identification marks.

A practical reminder that there could be more to it than that came with the widespread introduction of pentode output valves. Even though they offered considerably more power output, with comparable distortion ratings, there were numerous complaints that they lacked the "sweetness" of the old-fashioned triodes, sounding shrill and harsh by comparison. (Shades of "transistor tone", 30 years later!)

Could it be that, with their intrinsically high output resistance, pentodes performed badly into a typical reactive loudspeaker load — published ratings notwithstanding? Initially, however, the "quick fix" was to wire a 0.02μF capacitor across the primary of the output transformer, as a brute force restraint on both treble response and distortion.

A more salutory lesson came with the release by RCA of their state-of-the-art all-metal 6L6 beam power tetrode. Used in conventional circuitry, it showed a marked tendency to self-destruct at high signal levels, by arcing across a glass bead insulator separating the plate lead from the metal shell.

A crack and a fizz, and another 6L6 had ceased to be!

While the problem should, perhaps, have been forseen by RCA, it did underline the fact that the load impedance presented by a typical loudspeaker was likely to exceed its measured DC resistance, not just by a few percent, but several 100%! Across such a load, a high-power, high-impedance driver — in this case a 6L6 beam tetrode — could generate a destructively large peak voltage.

In technical terms, a loudspeaker or loudspeaker system can be described as the "load", to which an amplifier delivers audio power ranging, typically, from a few tenths of a watt for a small portable radio, to a 100 watts or more for a large hifi system.

Logically, a loudspeaker should be capable of coping with the audio drive power available from the associated amplifier but there is more to it than merely ensuring a sensible balance between the power handling capability of one, and the rated power output of the other.

It is also necessary to ensure that a loudspeaker presents to the amplifier that order of (load) resistance into which the amplifier can most effectively deliver its output power. If, for example, the design of an amplifier is such that it calls for an 8 ohm load, complications can arise if it is used instead with, say, a 4 ohm or 16 ohm loudspeaker or system. More about that later.

Unfortunately, it is virtually impossible to design practical loudspeakers which will present to the amplifier a pure resistance load of a desired value. To start with, the ubiquitous "dynamic" loudspeaker depends for its very operation on a "voice" coil, exhibiting not only DC resistance but also inductance and distributed capacitance. Inevitably, inductive and capacitive reactance will be present, along with the DC resistance.

No less to the point, loudspeakers normally involve moving parts, which exhibit mass, momentum, inertia, stiffness, springiness and a tendency to mechanical resonance. In the ultimate, all of these mechanical properties reflect back into the load, as seen by the amplifier, as electrical analogs: equivalent resistance, inductance and capacitance, adding to the electrical quantities already present.

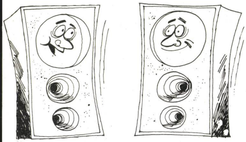
In April, 1938, the late Fritz Langford-Smith, Editor of the "Radiotron Designer's Handbook", presented a definitive paper on the general subject to the World Radio Convention in Sydney, organised by the IREE. It was entitled: "The Relationship Between the Power Output Stage and Loudspeaker". Although it related, at the time, to valve technology, it set out many broad principles equally applicable to modern solid-state devices.

I happened to be his assistant at the time and prepared the original diagrams from which Figs. 1, 2 and 3 have been redrawn.

Fig. 1 shows the impedance curve of a then-current 25cm loudspeaker (probably an AWA/Amplion model) with a nominal impedance of 12 ohms. It conforms to this figure, at most, over the range 100-700Hz. Below 100Hz, the impedance rises to a peak of 80 ohms at 70Hz (the main cone resonance) falling to reference again at 50Hz. Above about 700Hz, it rises progressively through 80 ohms at 10kHz — an increment of 6.5 times, or 650%!

It was no wonder that pentodes and tetrodes failed to perform as into a resistive load.

impedance
hat won't go away



"They're asking awkward questions about our impedance."
"Ah!"
"Not just R; I wish it were."
"I see . . ."
"It's not just C, either."
"Oh 'ell!"
"They know about L as well."
"You really do mean impedance . . ."
"That's what I Z!"

Fig. 2, from the same source, shows the nature of the impedance: inductive up to about 70Hz, changing to capacitive from just above 70Hz to about 190Hz, and then reverting to inductive for all frequencies above 200Hz. Only across a narrow band, centred on 200Hz, could the particular loudspeaker be said to present its rated load: 12 ohms, resistive.

Fig. 3 shows the combination of electrical components necessary to duplicate the impedance and phase characteristics of Figs. 1 and 2, up to 400Hz. Considerable elaboration would be necessary to simulate the curves above that frequency but, at least, the diagram conveys some idea of how even a simple loudspeaker appears to the drive amplifier. More importantly, it emphasises the fact that loudspeaker "resistance" is a mythical quantity.

In his paper, Langford-Smith pointed out that, for a given level of drive signal, a low impedance output stage tended to produce a constant voltage across the load, irrespective of variations in the load impedance. For this reason, triode output stages tended not to exaggerate the bass resonance (71Hz in Fig. 2) or the rising treble response above 1kHz. High impedance stages, on the other hand, (eg pentodes and tetrodes) exaggerated both effects, because their output voltage tended to rise and fall with load impedance.

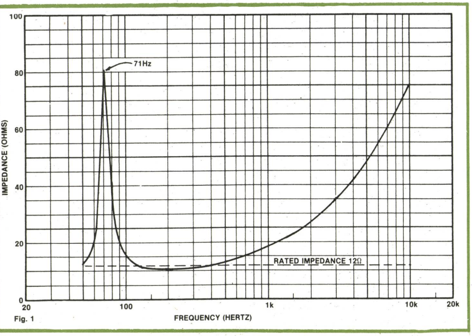


Fig. 1

Fig.1: The impedance curve of a traditional receiver-type 10in (25cm) loudspeaker, with a nominal impedance rating of 12 ohms. It was probably mounted on an open baffle.

He drew attention also to loudspeaker damping. When a loudspeaker cone tended to "overshoot" by reason of its mass and momentum, or to oscillate freely at a natural resonance, its surplus mechanical energy could be absorbed ("damped") much more rapidly in a low impedance output stage than in one with higher impedance.

These were the facts behind the then-preference for triodes, and the criticism of pentodes and tetrodes — facts which had at least as much to do with the limitations of the load, as with any vagaries of the valves!

Although the behaviour of a high impedance output stage could be modified by the use of a top-cut filter, Langford-Smith maintained that the use of (voltage) negative feedback was much to be preferred. He went on to show that, with negative feedback of the order of 8-11dB, a typical receiver type output pentode or tetrode could offer essentially the same performance as a power triode, but with improved efficiency in terms of the power supply.

In fact, the next generation of domestic receivers and amplifiers followed this general design philosophy, using pentode or tetrode output stages, with 10-12dB of negative feedback in a modestly configured circuit and with distortion figures hopefully below 3% at rated output. Peace reigned!

But then followed the call for ever lower figures of distortion, adding up to more complex circuit arrangements using a greater amount of feedback over more stages. In a roundabout way, that stirred up the problem of loudspeaker impedance all over again.

When the amount and the extent of negative feedback is increased, in the interests of reduced distortion, lower output impedance and flatter frequency response, it becomes progressively more important to ensure that the feedback does indeed remain "negative" — a requirement that applies no less to modern solid-state amplifiers than to classical valve designs such as the "Williamson" (ref. "Wireless World") or our own ultra-linear "Playmasters".

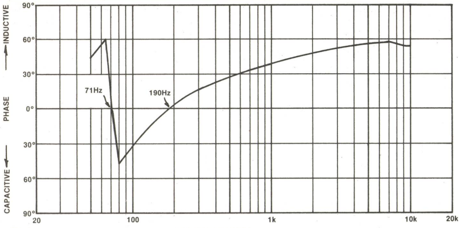


Fig. 2

Fig.2: The phase characteristics of the same loudspeaker as for Fig.1. The impedance approximates 12 ohms resistive only within a narrow band centered on 200Hz.

Loudspeaker Impedance

The problem is that reactive effects are present in any amplifier, which modify its phase response in the supersonic (and perhaps subsonic) region. Thus, even though the feedback may be strictly negative over the entire audible range, phase rotation effects can still cause the feedback to become positive somewhere within the overall passband, and therefore apt to promote instability. The problem multiplies with greater amounts of feedback and with the number of stages/components included within the feedback loop.

In an elementary way, Fig. 4 illustrates the problem which faces the designer of a high-gain high-quality amplifier, whether valve or solid-state. He can manipulate the internal design to ensure that it is stable at all frequencies, when looking into a resistive load of a certain order, or even into an open circuit. But how will the amplifier behave when it is terminated by a predominantly capactitive or inductive load instead or by a particular combination of L, C & R found in somebody's loudspeaker system? Will some unforseen combination of components cause enough phase rotation in the load, at some frequency, to promote instability?

In an extreme case, amplifiers have even been known to "take off" when provoked, not so much by a particular loudspeaker system, but by connecting leads having (for the amplifier) an unfortunate order or combination of inductance and capacitance.

Fortunately, the matter is well enough understood, these days, for actual or incipient instability not to be a problem for most amplifiers, most loudspeaker systems and most connecting leads. Indeed, some amplifier manufacturers are sufficiently confident to specify their product as "unconditionally stable".

But enough of phase and stability; let's get back to loudspeaker impedance and to the load values specified for typical domestic amplifiers.

In developing a new amplifier, the designer has to nominate a certain order of load, such that the output device(s) can develop across it an appropriate output voltage swing, without exceeding device ratings for maximum peak current.

For the sake of commercial convenience, he will probably recommend one or more of the currently popular values — 4 or 8 ohms — and list the corresponding power output, distortion level, frequency response, and so on. As far as possible, these recommended operating conditions should be observed.

Normally, however, no special difficulty will result if an amplifier is operated into a load higher than specified; eg into 16 ohms instead of 8 ohms. Because of the negative feedback, there will be little change to the output voltage swing, the distortion level or the frequency response but the available power (E^2/R) will be reduced. If there is power to spare, or the speakers are acoustically efficient, this may not matter all that much.

But descreasing the order of load impedance is a different matter, eg from 8 ohms to 4 ohms. In this case, the negative feedback tries to sustain the signal output voltage, resulting in higher output current through the load. This, in turn, may yield higher power output but with more stress on the output stage devices — conceivably sufficient to endanger them at peak signal levels.

A valve output stage will generally take such abuse without getting more than "hot under the collar" and suffering a possible reduction in overall life span but solid-state devices could blow a fuse or, more seriously, blow themselves by reason of excessive current or by exceeding their "safe area of operation". By way of explanation most power transistors have reduced power handling at higher voltages within their rated range and consequently special design measures are required to ensure that amplifier operation into normal loads does not exceed the transistors' safe operating limits.

To assist users, amplifiers are frequently rated for two orders of load impedance (per channel, in the case of stereo). usually 8 and 4 ohms. It is safe to

Fig.3: To an output stage, a loudspeaker appears like a complicated electrical network. This much simulates Figs 1 and 2 only below 400Hz.

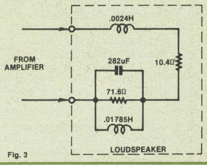


Fig. 3

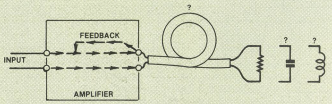


Fig. 4

Fig.4: Amplifiers involving a large order of negative feedback can sometimes prove unstable when used with leads and/or loudspeakers exhibiting unusual reactive properties.

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LBV 6333 HEP 90388/A

Loudspeaker Impedance

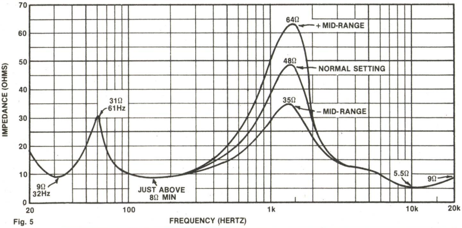

Fig. 5

Fig.5: The impedance curve of a popular medium-priced hifi 8-ohm loudspeaker system, using the bass reflex principle and fitted with a 3-position "presence" switch. Note the dip in impedance at 10kHz.

use an amplifier with a nett load impedance equal to, between, or larger than the specified values — but not substantially less than.

Where an amplifier has provision for multiple loudspeaker systems (typically "Main" and "remote") the impedance presented by the two systems, operating simultaneously, should not be less than minimum figure for which the amplifier is rated. Two 8 ohms systems would be the obvious choice for an amplifier with a minimum rating of 4 ohms. In fact some amplifier designers go so far as to have the main and remote loudspeakers connected in series when both are selected. This ensures that excessively low values of load are unlikely but it does nothing for the damping of each individual loudspeaker system!

And that brings us to consideration of Fig. 5, based on the published impedance curve for a medium-priced, bass reflex hifi system, (actually the original Kef 104) with a nominal impedance rating of 8 ohms. It is much more typical of present day systems than Fig. 1.

The impedance is just under 20 ohms at 20Hz, dipping to 9 ohms between the two bass reflex peaks. At the upper bass peak, the impedance rises to 31 ohms, falling to just above the rated 8 ohms between 100 and 300Hz. From there it rises to peaks of 35, 48 or 64 ohms, depending on the setting of the mid-range "presence" switch. At around 3kHz, the impedance falls to below 15 ohms and then, with a slight plateau at 5kHz, passes through a dip to 5.5 ohms at 10kHz and back to 9 ohms at 20kHz.

In looking at Fig. 5, it is important to remember that it is a curve depicting impedance, **not** frequency response. If such a system were driven by an amplifier having a high output impedance (eg non-feedback pentodes or bipolar transistors) the frequency response might indeed take on something of the same shape. However, when driven, as normal, by a low-impedance (constant-voltage) amplifier, variations in the load have only a very secondary effect; in fact, the particular loudspeaker is credited with a frequency response flat within a very few dB from 50Hz to 20kHz.

While, for the most part, the impedance approximates, or remains safely above 8 ohms, it does dip to 5.5 ohms at 10kHz — raising the question as to whether it would pose any hazard to an 8 ohms amplifier.

The answer, in this case is "probably no", if only because the risk of encountering sustained high-level drive in the 8-15kHz region is not very great under ordinary listening conditions. But one could be more concerned with profound dips that occur further down in the range, as with some loudspeaker systems.

The general answer has to be that, although not uncommon, dips in the impedance curve below the nominal rated value are undesirable, in principle, especially if they fall below, say, 75% of the nominal value; ie below 6 and 3 ohms respectively for 8 and 4 ohms systems. They would certainly add to the risk of using Main and Remote loudspeakers or less than the appropriate nominal impedance.

The presence of dips in the impedance curve also has a bearing on the choice of cable connecting the loudspeaker system to an amplifier.

Taken together, the resistance of the contacts and of the cable itself should be as small as possible relative to the impedance of the load — the loudspeaker system. Certainly, it should not amount to more than 5% of the load impedance, representing a maximum resistance of 0.4 ohms for an 8 ohms system, as in Fig. 5. Ostensibly, this would introduce a loss of less than 0.5dB and make no discernable difference to the sound, as heard.

If it was purely a question of signal level, the matter could possibly rest there but the variation in impedance with frequency introduces another consideration:

In those sections of the curve in Fig. 5, where the impedance approximates 8 ohms, the cable loss might indeed be just under 0.5dB, as predicted. However, at 60Hz, where the system impedance is much higher, the cable loss would be a mere 0.1dB, and less again in the region 1-2kHz. But, at the impedance minima, around 10kHz, it would range around 0.6 to 0.7dB.

From this flows the contention that, with practical loudspeaker loads, contact and cable resistance causes not just a loss in level (which might pass unnoticed) but a variation in frequency response or a "colouration", which might be more apparent.

The counter argument is that the frequency response of a practical loudspeaker system in a practical listening room is already so peaky that it is fantasy to worry about plus-and-minus an extra quarter-decibel!

However, human nature being what it is, the impedance "ogre" still has the last laugh, when he sees even the counter-arguers doubling and trebling the gauge of their cables "just in case".

But he must really fall about at the sight of ultra-purists "wiring" up their loudspeaker systems with lead pipe!

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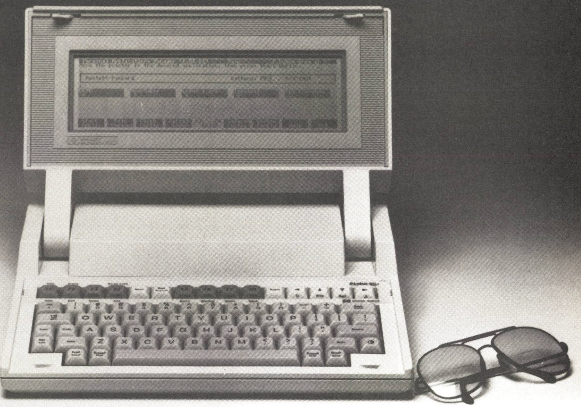

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LBV 6333 HEP 90388/B/R

HI-FI REVIEW

Philips CD303 compact disc player

Slimline construction, front loading and easy-to-use features are the key aspects of the CD303 compact disc player from Philips. The simple styling, high standard of finish, and excellent presentation combine to produce a very impressive unit.

As distinct from the majority of CD players which are manufactured in Japan, the CD303 is made in Belgium. The first impression one gets is that this unit is very solidly constructed. It weighs in at no less than 8.2kg and has overall dimensions of 420 x 315x 88mm (W x D x H).

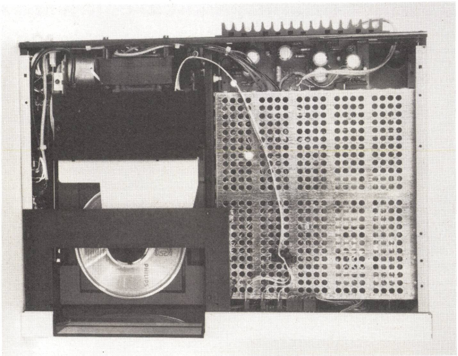
The impression of solid construction is reinforced by the presence of a heavily-finned heatsink at the rear of the unit. This heatsink is used to dissipate the heat generated by the regulators in the power supply circuitry.

Styling of the CD303 is modern, though typically European. The front panel is finished in satin aluminium with black lettering, while blue/grey perspex protects the top and front of the slide-out disc drawer. Unlike many CD players now on the market, you can actually see the disc while it is being played.

A wrap-around silver/grey cover highlights the appearance of the CD303. All in all, it is a most attractive unit.

In fact, Philips has put a great deal of thought into the presentation of this product. Included in the price are several very useful and interesting accessories contained in a moulded plastic folder. Apart from the usual instruction manual, the folder contains a disc cleaning cloth, two handbooks on digital disc technology, a disc catalog, and an excellent demonstration disc containing both classical and contemporary music.

View inside the CD303. The main PC board is covered by a punched metal shield.



The plastic folder even has provision to store the two transport locking screws which must be removed before the player is used. We've commented on the need for this type of provision before, but Philips is one of the few manufacturers to solve the problem.

As with previous Philips players, the CD303 uses the now popular slide-out drawer system for disc loading. Just press the open/close button and the drawer slides out ready to receive the disc. This system of disc loading is the easiest to use, as there is no need for the user to precisely locate the disc in the drawer.

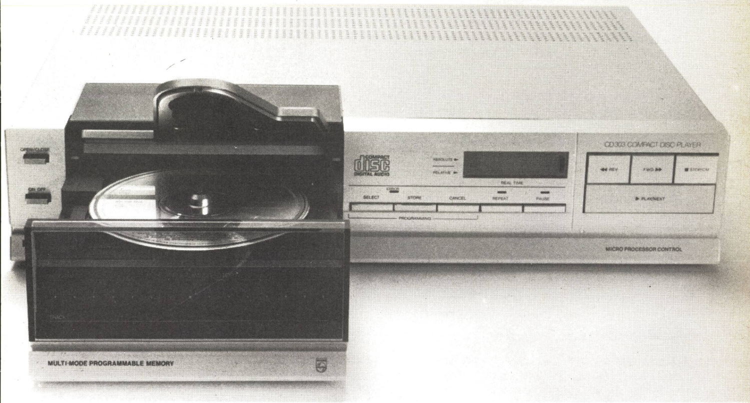
The front panel layout is excellent and contributes greatly to the ease of use. Immediately to the right of the disc drawer are three programming pushbuttons — Select, Store and Cancel — together with two further pushbuttons for repeat and pause. The main player controls are grouped at the far right and include Reverse, Forward, Stop/Clear, Memory and Play/Next.

Several options are available when playing a disc. Firstly, the programmng facilities can be ignored and, by simply pressing the Play/Next button, the entire disc can be played from start to finish. If, during play, the Play/Next button is pressed, the player will skip to the start of the following track.

Alternatively, the player can be stepped backwards or forwards by use of the Reverse and Forward switches. Pause or Stop/CM can be pressed at any time during play, while the repeat button causes the player to continuously repeat the programmed sequence of tracks.

The three programming controls (Select, Store and Cancel) work in conjunction with two horizontal rows of green LEDs located behind the perspex panel at the front of the disc drawer. Each row contains 15 LEDs, the top row (Program) indicating the number of tracks on the disc and the bottom row (Track) indicating the current track and/or those tracks that are programmed.

Programming is easy. Up to 15 tracks can be programmed to play in any order



he CD303 is easy to use and can be programmed to play up to 15 tracks in any sequence.

nd are entered using the Select and tore switches. The user can remove rogrammed selections one at a time by ressing the Cancel switch or, by ressing the Stop/CM switch, the entire rogramming sequence can be erased.

A minor drawback is that the LED isplay shows only those tracks that have een selected. It does not indicate the rder in which they have been selected nd thus the order in which they will be layed.).

Programming errors are indicated by a ed Error LED, while two further red EDs indicate pause and repeat. When he disc is in play, a 4-digit vacuum uorescent display indicates the "Real ime". This can be displayed in two odes: "relative time" indicates the lapsed time of the particular track, hile "absolute time" indicates the lapsed time of the disc.

In practice, this means that locating a articular track after the 15th can be ather awkward. One has to "zero in" on he required track using the Play/CM, everse and Forward controls. ortunately, most compact discs have ss than 15 tracks, so this should not reate any great hardship.

Oversampling

As in previous Philips CD players, the CD303 uses an oversampling technique to convert the digital information on the disc into an analog signal. This involves increasing the original sampling frequency by four times from 44.1kHz to 176.4kHz. The sampled signal is digitally filtered, fed to a 14-bit D/A converter, and thence to a sample and hold circuit.

A third order Bessel filter with a 3dB rolloff point at 30kHz provides the final analog filtering.

Note that the CD303 is a full 16-bit system, despite the use of a 14-bit D/A converter. This is made possible by the oversampling technique employed, and by duty cycle modulating the least significant bit. The main advantages of this technique are lower noise and improved linearity compared with other 16-bit systems, and minimal phase shift over the audio spectrum.

The error correction system used is the Cross Interleave Reed-Solomon Code, or CIRC for short. This is designed to correct erronous readings due to disc defects, dust, fingerprints and scratches, or irregularities in the disc tracking mechanism. The circuit is designed to

Quoted Specifications

Number of channels	2
Frequency range	20-20,000Hz, ±0.3dB
Dynamic range	≥90dB
Signal-to-noise ratio	≥90 dB (20-20,000 Hz)
Channel separation	≥86dB (20-20,000Hz) 91dB (at 1000Hz)
Total harmonic distortion (incl. noise) at max. output level	≤.005%
Wow and flutter	quartz crystal precision
D/A conversion	16 bit with digital filtering
Error correction system	Cross Interleave Reed Solomon Code (CIRC)
Audio output level	2V RMS typical

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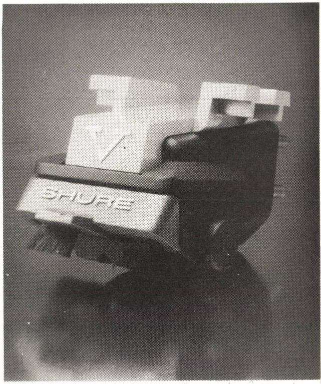

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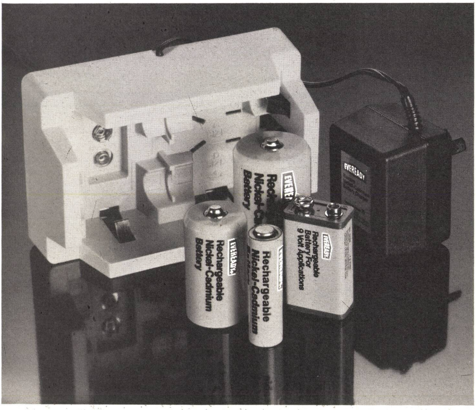
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either mute of interpolate the signal so that defects will generally not be noticed.

The works

Removing the top and bottom covers reveals that the CD303 is well constructed and packed full of components. The disc driver and laser assembly occupies approximately one third of the interior space, while the remainder is taken up by a large PC board enclosed in a perforated metal shield. Unlike some CD players, the power transformer is mounted internally.

The rear panel is simplicity itself. Instead of using two RCA output sockets, the CD303 has a twin shielded audio lead which emerges from the rear panel via a cord clamp. This lead measures about 1.4m long and is terminated in two RCA plugs for connection to a stereo amplifier.

The CD303 is action. The track and program indicator LEDs are at the front of the disc drawer while the 4-digit readout indicates elapsed time.

Performance tests

For most of the performance measurements we used the Technics test disc in conjunction with our Sound Technology automatic nulling distortion bridge plus a dual channel oscilloscope.

First, we ran a check on the linearity. This test is carried out using a 1kHz tone which is stepped down in 10dB steps to −90dB. The idea is to check how the output level changes in relation to the recorded level. Most CD players are pretty good in this respect and the CD303 was no exception. It had a discrepancy of just 1dB at −80dB and was around 0dB for signals from 0dB to −70dB.

Frequency response tests showed a remarkably flat response over the entire audio spectrum. There was a slight dip of 0.25dB at 15 and 18kHz, while the response was 0dB down for all other frequencies in the range from 20Hz to 20kHz. This is an excellent result.

The CD303 is also very quiet, with a measured signal-to-noise ratio of 97dB. At this level of performance, noise from the following stereo amplifier is likely to predominate.

At this point, we ran into some difficulties with our measurements. While we had no reason to doubt the quoted total harmonic distortion (THD) figure of .005%, we had difficulty confirming this. The distortion was masked by a high-level 88.2kHz signal (twice the sampling frequency) which resulted in a measurement of 0.27%. This reading dropped to .012% when we inserted a 20kHz third order (60dB per decade) filter.

In practice, the residual 88.2kHz signal will not produce any audible effects since any beat signals will be well outside the audio range.

Separation between channels was also checked and resulted in readings of −90dB at 100Hz; −90dB at 1kHz; −86dB at 10kHz; and −83dB at 20kHz. This confirms the 90dB at 1kHz specification quoted by Philips.

We also tested the CD303's handling of defects using the Philips No 4A test disc. This disc has intentional interference markings to simulate scratches, dust and fingerprints. The CD303 was able to compensate for these defects since we were unable to hear any difference in the audio at the defect points.

Vibration resistance was tested in a less objective way by bumping and

continued on page 118

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Add-on decoder for AM stereo

AM stereo is now broadcast in Australia on an experimental basis. This add-on decoder works with the Motorola C-QUAM system. We show how to add it to two recent Playmaster tuners.

by JOHN CLARKE & GREG SWAIN

There is growing pressure in Australia for the official introduction of AM stereo. As we go to press, the Department of Communications has yet to give its decision as to whether all four competing AM stereo systems will go ahead or whether one system, such as the Motorola, will be preferred. The other three systems are Harris, Kahn and Magnavox.

In the United States, the Motorola system is currently the front runner. It has been chosen by more radio stations than any other and has been adopted by several major car manufacturers, including General Motors, Ford, Chrysler and Nissan. Many Japanese hifi companies have also adopted the Motorola system. That's not to say that the other systems will disappear — it's possible that tuners capable of automatically decoding all four systems will be developed.

With the situation unlikely to be resolved in the near future, we have decided to present this decoder based on the Motorola C-QUAM system. There are currently five stations using the Motorola system in Australia: 2WS in Sydney; 3UZ, 3KZ and 3AK in Melbourne; and 5KA in Adelaide.

Let us state right from the beginning, though, that many AM tuners are not capable of being converted to stereo. We'll explain the reasons for that later and give you some pointers on choosing a good candidate for conversion. In addition, we'll show you how to add the decoder to the Playmaster AM/FM Stereo Tuner (Nov '78) and the Playmaster Hifi AM Tuner (Dec '82).

What is C-QUAM

C-QUAM is an acronym for *C*ompatible *QU*adrature *A*mplitude *M*odulation. That's certainly a mouthful — let's see what it means.

First, the system is compatible with existing tuners. That means that any ordinary (mono) AM tuner can receive a stereo broadcast and produce the same result as if it received a mono signal. The AM stereo system does not make existing tuners obsolete.

Second, C-QUAM is a quadrature system which means that it uses the relationship between two carrier signals that are 90° out of phase to encode the left minus right (L−R) information. At the same time, the mono signal (L+R) is the conventional amplitude modulated signal.

There's a problem with quadrature modulated signals though. They produce distortion in the envelope detectors (usually a diode) of normal AM tuners. That's because the envelope detector sees the sum of the two carriers. As shown in Fig. 1a, the magnitude of the sum of those two vectors — which the tuner's envelope detector would see — is:

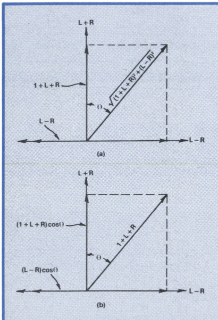


Fig. 1: To avoid distortion in normal AM tuners, quadrature signals must be converted to a compatible form.

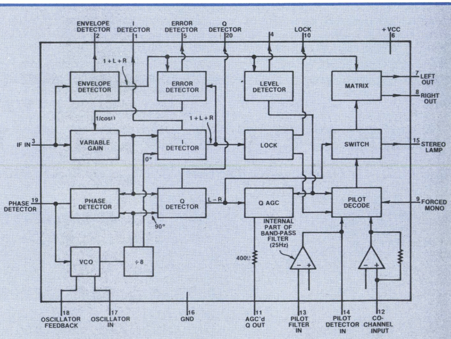
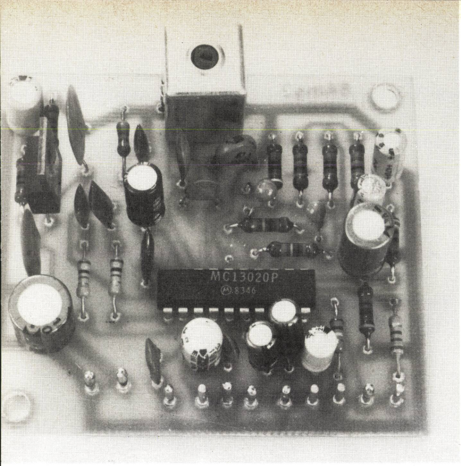


Fig. 2: Block diagram of the MC13020 AM-stereo decoder IC.



The assembled stereo decoder. There is also a capacitor under the PCB.

$\sqrt{(1 + L + R)^2 + (L - R)^2}$.

However, the envelope detector in a standard AM tuner expects to see simply the carrier and the left and right channel audio, or 1 + L + R. It is the difference between the two expressions that is the cause of the distortion problem.

Motorola found, however, that they could eliminate the problem by multiplying each carrier axis by the cosine of the angle that resulted from the addition of the L + R and L − R signals. Fig. 1b shows that when this is done, the result is the 1 + L + R signal that we want — the standard AM tuner sees this signal as the same signal received from a monaural AM broadcast. Thus we have complete compatibility.

The C-QUAM system also adds a 25-Hz pilot tone to the L − R information at 4% modulation. This serves several purposes: it signifies that a stereo transmission is present; it permits decoding of the L − R signal, and it aids in the control of mono-stereo switching.

The MC13020P

At the heart of the decoder is a single integrated circuit, the Motorola MC13020P. This is housed in a standard 20-pin dual-in-line package. A block diagram of the IC is shown in Fig. 2 while Fig. 3 is a schematic of the complete decoder circuit.

Taking an overall look at the block diagram of the decoder IC (Fig. 2), we see that the decoder takes the output of the AM IF amplifier, decodes the C-QUAM signal, and provides left- and right-

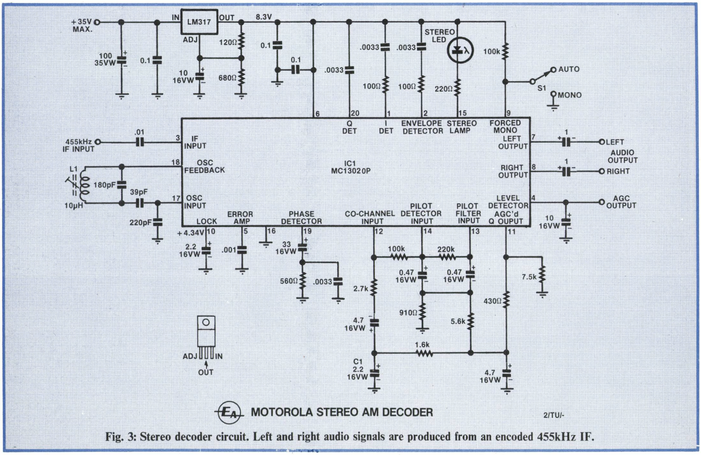
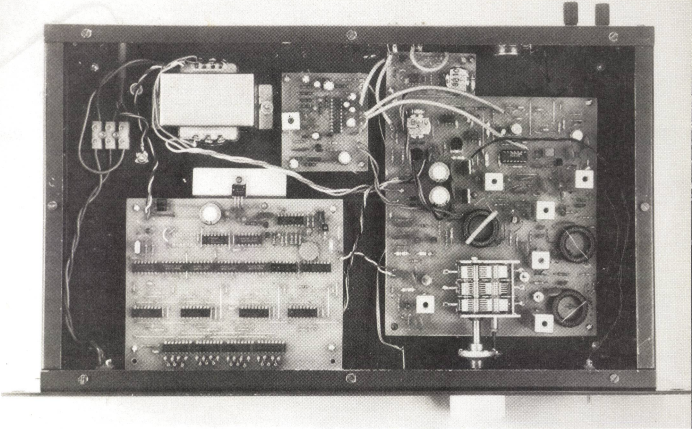


Fig. 3: Stereo decoder circuit. Left and right audio signals are produced from an encoded 455kHz IF.



The decoder PCB fits easily inside the Hifi AM Tuner cabinet.

Add-on decoder for AM stereo

channel audio outputs. In the absence of a good stereo signal, it will produce an undegraded mono output from both channels.

The first step in decoding the stereo information is to convert C-QUAM to QUAM. That conversion is accomplished by comparing the outputs of the envelope detector and the I (L + R) detector in the error detector.

Let's say, for example, that the incoming signal is monaural. Then it consists only of L + R information, and the envelope detector and I detector see the same signal. Therefore the error detector does not produce an error signal.

However, when the incoming signal is stereo, there will be an error signal produced. The envelope detector sees the same signal as it did before (1 + L + R) because it is not sensitive to the phase modulation. But the I detector is sensitive to phase modulation and sees only the (1 + L + R) Cosθ information. When both signals are sent to the error detector, a 1/cosθ correction factor is produced.

In the variable-gain block, the incoming C-QUAM signal is multiplied by the 1/cosθ factor to derive a conventional quadrature or QUAM signal. This can be synchronously detected by conventional means.

The process to detect or demodulate the conventional quadrature signal involves first deriving a reference phase from the transmitted signal. That's the purpose of the phase-locked-loop (PLL) that we'll now describe. The phase detector is a product detector — its output is equal to the product of the two input signal voltages (in this case, a reference carrier from the VCO and the QUAM signal from the variable-gain block). If the two signals are of the same frequency and 90° out of phase, the filtered DC output of the detector will be zero. This DC output is fed back to the VCO as an error signal. Thus, the VCO locks onto the input carrier frequency and we have our phase reference to the I and Q demodulators.

The RC network on pin 19 (see Fig. 3) filters the output of the phase detector to ensure a steady DC error signal to the VCO.

The internal VCO operates at eight times the IF input, thus ensuring that its frequency is well outside the broadcast band. Typically, the IF will be 455kHz so the VCO runs at 3.64MHz. Note, however, that many synthesised tuners use a 450kHz IF and this requires a VCO frequency of 3.6MHz.

Coil L1 and the capacitor network o pins 17 and 18 (Fig. 3) set the VC frequency. This network is easil adjusted to suit either IF.

The level detector senses carrier leve and operates on the Q AGC (automati gain control) block to provide a constan amplitude 25Hz pilot signal at pin 11. I also sends information on signal strengt to the pilot decoder.

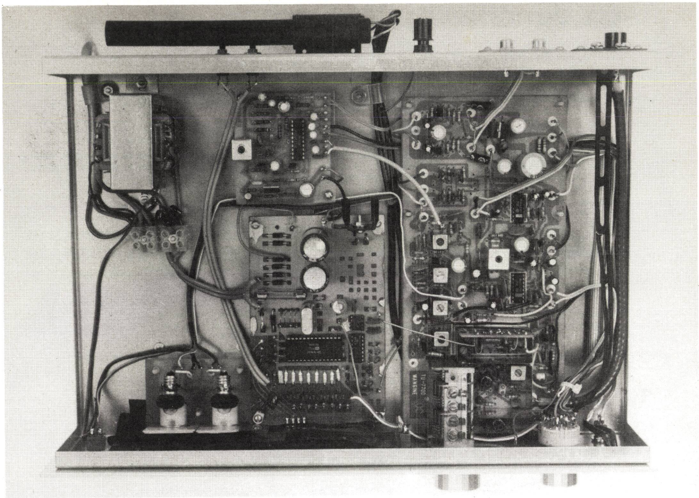
The Q AGC (pin 11) output drives low-pass filter, made up of a 400 internal resistor, a 7.5kΩ resistor, a 430 resistor and a 4.7μF capacitor.

From that point, an active filter (mad up of both internal and externa components) is coupled to the pilo decoder, pin 14, and another low-pas filter is connected to the co-channe input, pin 12.

Stereo/mono switching

Automatic stereo/mono switching i performed by the pilot decode bloc This has two modes of operation whic we will now describe.

On a strong signal, the decoder wi switch to stereo after it sees seve consecutive cycles of the 25Hz pilo waveform. When conditions are ba



Playmaster AM/FM tuner with the stereo decoder fitted.

however, the pilot decoder detects the interference and waits until it sees 37 consecutive cycles of the 25Hz pilot tone (that takes about 1.5 seconds) before it goes into the stereo mode.

Switch S1 provides manual switching to mono operation by pulling pin 9 low. This switch can be regarded as optional and, in fact, was not used for the Playmaster tuner conversions.

If no pilot is detected for seven consecutive counts, it is assumed the incoming signal is mono and the decoder is again switched to the long count. This reduces the possibility that noise or signal-level fluctuations will cause stereo triggering. The decoder will also switch to the long count if the PLL is out of lock, or if interference is detected by the co-channel detector before seven cycles are counted (each disturbance will reset the counter to zero). The level detector prevents the decoder from going into stereo if the IF input level drops 10dB, but will not affect the pilot counter.

Finally, the decoder will automatically switch to mono if there is a 50% reduction in the level of the 25Hz pilot signal into the pilot decode circuit.

Once the decoder has entered the stereo mode, it will switch instantly back to mono if either the lock detector at pin 10 goes low, or if the carrier level drops below the preset threshold. Seven consecutive counts of no pilot will also cause the switch to mono.

When all inputs to the pilot-decode block are correct, and the appropriate (long or short) count is completed, the switch block is enabled. This turns on the stereo-indicating LED and passes the L − R information to the matrix block. The matrix block decodes the stereo information and presents the left and right channel signals to pins 7 and 8 respectively.

In stereo mode, the co-channel input (pin 12) is disabled. Co-channel or other noise is now detected by negative excursions of the I detector. When those excursions reach a critical level, the lock detector switches the system to mono, even though the PLL may still be locked. This scheme prevents chattering in and out of stereo because of a marginal signal or high noise-levels (such as during a thunderstorm).

If you wish to decrease the effectiveness of the interference sensing (to keep the decoder in its stereo mode in the presence of some narrow spike type of interference), the 2.2μF capacitor, C1, may be increased to as much as 47μF.

Power for the circuit is derived from any convenient +10 to +35V DC rail within the tuner and regulated to +8.3V by an LM317 3-terminal regulator. This output voltage is set by the 120Ω and 680Ω voltage divider on the OUT and ADJ terminals. Note that the supply rail must be able to deliver up to 40mA continuously.

Selecting a suitable tuner

Not every AM tuner can be converted to receive broadcasts in stereo. But if you are careful when you examine the tuner's capabilities, the conversion should go smoothly. Here's what to look for:

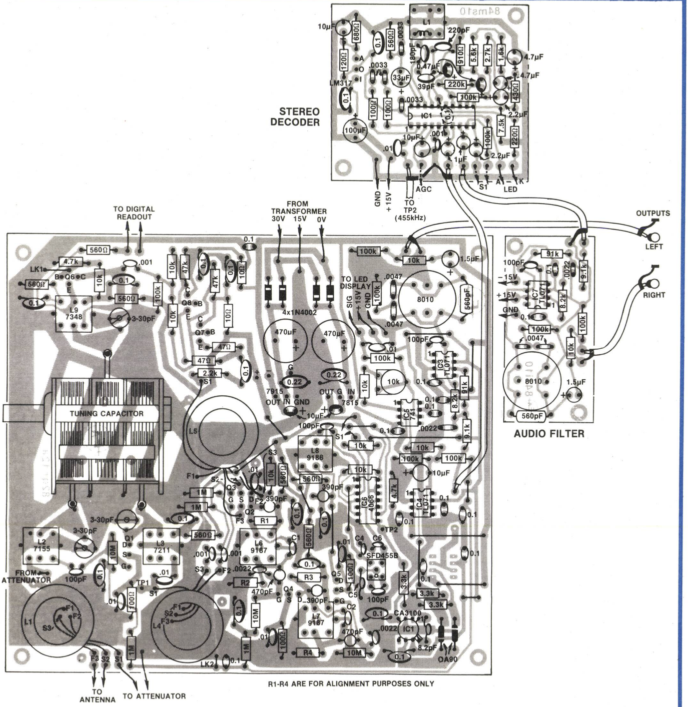
1. Old vacuum-tube radios are unacceptable. You'll undoubtedly have problems because of the high voltages and temperatures involved.

2. Cheap pocket radios, clock radios, small table radios, and the like should not be used in most cases. They typically have narrow bandwidths, poor sensitivity, and self-generated phase and frequency modulations that can seriously degrade channel separation and increase distortion and noise. (The C-QUAM system uses phase-related information, so the decoder is sensitive to phase variations or modulation.)

3. Some manually-tuned tuners, whether variable-capacitor or variable-inductor types, may cause audible microphonics when in stereo mode. (The Playmaster tuners are quite OK in this regard.) Receivers with self-contained speakers may also be subject to microphonic problems because of the speaker vibrations. Those vibrations may generate phase modulation and the associated problems of poor separation, distortion, and noise.

4. The local oscillator must be stable and produce a reasonably clean sinewave. An unstable oscillator or a severely distorted waveform may cause distortion.

5. Tuners with synthesizer front ends or logic-controlled varactor tuning are best adapted to AM stereo because of the more precise, automatic tuning, and better immunity to tuning disturbances. However, those types of recievers are not guaranteed to be trouble free. Phase modulation can originate from the PLL comparison frequency and may appear as an audible tone. Extra filtering may be needed on the control voltages from the logic circuits.



R1-R4 ARE FOR ALIGNMENT PURPOSES ONLY

Fig. 4: Parts layout and wiring diagram for the Hifi AM Tuner.

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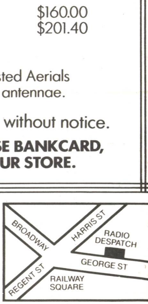


Add-on decoder for AM stereo

6. The AGC system of the tuner should be effective enough to provide a generally constant IF input to the decoder from all stations. In some tuners which use an IC for the AM tuner section, it is not possible to gain access to the IF signal.

7. A major advantage is a tuner with a tuned RF amplifier at the front end. The increased sensitivity and selectivity aid in stereo reception and stability.

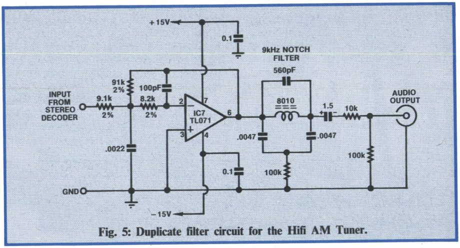


Fig. 5: Duplicate filter circuit for the Hifi AM Tuner.

Construction

All the circuitry, with the exception of the LED and the optional switch S1, is accommodated on a printed circuit board coded 84ms10 and measuring 72 x 65mm. Fig. 4 shows the parts layout.

No special procedure need be followed when assembling the PCB although we suggest that the smaller components be installed first. Note carefully the orientation of the semiconductors, electrolytic capacitors and the LED. We used PC stakes to terminate the external wiring connections.

Coil L1 consists of 50 turns of 36 B&S enalled copper wire close wound on Neosid coil former (see parts list). This is fitted with an F16 ferrite core slug and a shield can, and mounted directly on the PCB. Make sure that you terminate the coil leads to the base pins indicated on the parts layout diagram (Fig. 4).

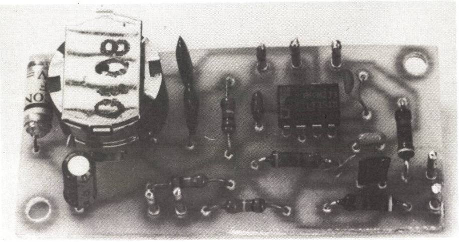
Note the 0.1μF capacitor shown dotted on the parts layout diagram. This mounts on the copper side of the PCB and is connected between pins 6 and 16 of the IC.

The AGC output is not used if converting an existing receiver, while the optional auto/mono switch was not used in the conversions to be described.

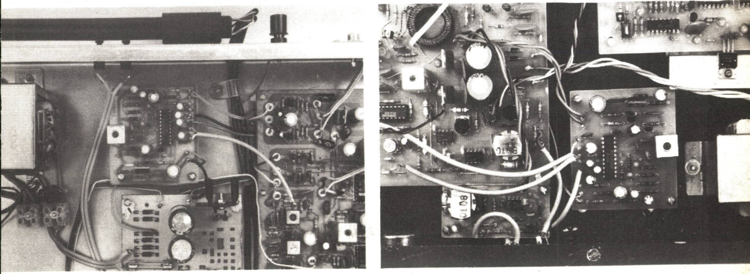
Installation

For quiet, clean stereo reception, the IF input signal level to the decoder must lie between 500mV and 1V peak-to-peak. If the tuner has a high IF output (ie, over 1V p-p), a series resistor can be added to drop the voltage to the desired level. The input impedance of the decoder is about 27kΩ.

The IF input is derived from the final IF stage immediately preceding the



Above: The LF351 IC in the audio filter is taken from the Hifi AM Tuner PCB.



Below: Close up view of the stereo decoder connections for the Playmaster AM/FM tuner (left) and the Hifi AM Tuner.

Add-on decoder for AM stereo

detector diode. Because AGC voltages are generally obtained from the detector, the existing detector should be left in circuit. To avoid conflict with the two audio channels coming from the decoder, the tuner's existing audio output must be disconnected.

The decoder assembly may be mounted in any convenient place inside the tuner, but try to keep it away from major heat sources such as a power transformer, output transistors and heatsinks. Use shielded cable for the IF input and audio output connections and connect the cable shields to earth at one end only.

Failure to observe this precaution could result in an earth loop. The only common earth connection between the decoder PCB and the tuner is via the power supply (see Fig. 4).

The left and right audio outputs have a nominal 200mV RMS output level and can be connected directly to the tuner or auxiliary inputs of a stereo amplifier. If the conversion is in an AM/FM tuner, the band switch wiring will have to be modified so that the outputs are not switched in parallel when in the AM mode.

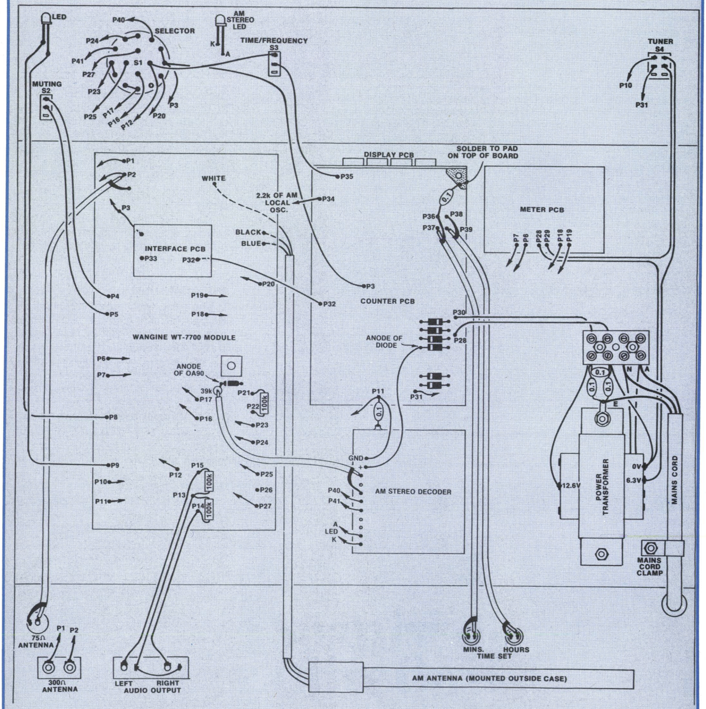


Fig. 6: Wiring connections for the Playmaster AM/FM tuner. Note the power supply connection to the diode on the counter PCB.

We estimate that the current cost of parts for the Stereo Decoder is

$20-25

Parts for the Audio Filter are estimated to cost $17-20. These prices include sales tax.

Once the installation has been completed, it is necessary to carry out the setting up procedure. Tune in a station, connect your DVM (or multimeter) to pin 19 of IC1, and adjust the slug in coil L1 for a reading of 4.1V. This done, check that the voltage on pin 10 is approximately 4.3V (note: this indicates that the VCO is in the "lock" condition).

You are now ready to check for stereo reception. Tune into your local stereo station (one that is broadcasting in C-QUAM) and check that the pilot LED lights after a few seconds. Note that accurate tuning is necessary for stereo reception — really, you must be "spot on".

If interference prevents stereo reception, try increasing C1 up to a maximum value of 47μF.

Proven conversions

We added the decoder PCB to the Playmaster Hifi AM Tuner and to the Playmaster AM/FM Tuner. Fig. 4 shows the wiring details for the Hifi AM Tuner.

As shown, the IF input for the decoder PCB is derived from test point TP2. This test point precedes the precision rectifier (IC1) in the tuner circuit. The precision rectifier (CA3100) is left in circuit and the audio chain broken by removing buffer amplifier IC2 (TL071) and the wire link between IC2's pin 6 and resistor R5 (9.1kΩ).

The left channel output from the decoder PCB is now connected to the tuner's existing audio filter (ie, to the input of the 9.1kΩ resistor). From there, the signal passes through the whistle filter to the left channel output socket. In the case of the right channel, a duplicate filter circuit must be constructed.

Fig. 5 shows the duplicate filter circuit. This is built on a PCB coded 84fi10 and measuring 67 x 33mm. Fig. 4 shows the parts layout and external wiring connections.

Both the decoder and filter PCBs are mounted in the chassis on 19mm standoffs. Power for the two PCBs is derived from existing supply points on the main tuner PCB. Don't forget to remove the wire link between the two output sockets, otherwise you definitely won't get stereo.

The indicator LED can be mounted on the front panel, adjacent to the signal strength display.

PARTS LIST

Stereo Decoder Board

1 PCB, code 84ms10, 72 x 65mm
1 MC13020P stereo decoder IC (Motorola)
1 LM317T 3-terminal regulator
1 red LED
1 Neosid 722/1 coil former with 7100 screening can, F 16 screw core, and 5027/PLD base plate
1 200mm length of 0.125mm (36 B&S) enamelled copper wire
4 19mm standoffs

Capacitors

1 100μF/35VW PC electrolytic
1 33μF/16VW PC electrolytic
2 10μF/16VW PC electrolytic
2 4.7μF/16VW PC electrolytic
2 2.2μF/16VW PC electrolytic
2 1μF/16 VW PC electrolytic
2 0.47μF/16VW PC electrolytic
3 0.1μF ceramic
1 .01μF ceramic
4 .0033μF metallised polyester
1 .001μF metallised polyester
1 220pF ceramic
1 180pF ceramic
1 39pF ceramic

Resistors (¼W, 2%)

1 x 220kΩ, 2 x 100kΩ, 1 x 7.5kΩ, 1 x 5.6kΩ, 1 x 2.7kΩ, 1 x 1.6kΩ, 1 x 910Ω, 1 x 680Ω, 1 x 560Ω, 1 x 430Ω, 1 x 220Ω, 1 x 120Ω, 2 x 100Ω

Audio Filter Board

1 PCB, code 84fi10, 67 x 33mm
1 TL071 op amp (use IC2 from Hifi AM Tuner)
1 8010 whistle filter coil
2 19mm standoffs

Capacitors

1 1.5μF/16VW PC electrolytic
2 0.1μF monolithic ceramic
2 .0047μF metallised polyester
1 .0022μF metallised polyester
1 560pF polystyrene
1 100pF ceramic

Resistors (¼W, 5% unless noted)

2 x 100kΩ, 1 x 91kΩ 2%, 1 x 10kΩ, 1 x 9.1kΩ 2%, 1 x 8.2kΩ

Miscellaneous

Machine screws and nuts, hook-up wire, shielded cable, solder, PC stackes etc.

The setting up procedure is exactly as described in "installation" above, while the whistle filter is adjusted by rotating the ferrite cup for the best null (see page 70, February 1983).

Fig. 6 shows the conversion details for the Playmaster AM/FM Tuner. The 455kHz IF signal is most conveniently extracted by making a connection to the anode of the 0A90 detector diode. In this case, however, the available signal level must be attenuated using a 39kΩ series resistor.

Continued on p117

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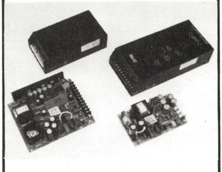

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HSC55-41	5V 6A, −5V 0.5A, 12V 2.5A, −12V 0.5A	enclosed	55 Watt	$80
HSC75-32	5V 3A, 24V 2.2A, −12V 0.2A	open frame	75Watt	$95
HSC125-40	5V 10A, 12V 3.5A, −12V 0.5A separate 12V 2.5A	enclosed	125 Watt	$150

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Jarre's music drifts and flows through "Fishing Junks at Sunset" to the attacking synthesisers of "Magnetic Fields". His unique style of electronic music and the haunting magic of the Peking Conservatoire Symphony Orchestra, although vastly different in timbre and technique, complement each other all the more magnificently on the Philips Compact Disc Player.

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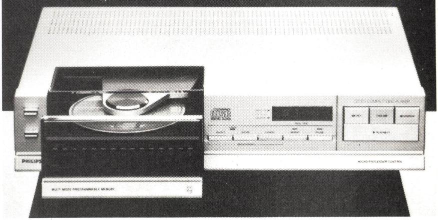

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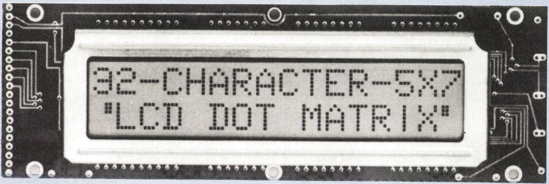


New range of LCD panels

Varitronix have just announced a range of dot matrix LCD panels which include RAM, character generator ROM and multi-plexing drivers. These versatile units are ideal for interfacing with microprocessors to provide up to 160 characters of information.

An accessory electroluminescent panel can be sandwiched between the LCD and its mounting frame so that bright blue characters will appear in the display. This is powered by a thimble-sized inverter. Alternatively, flourescent backlighting can be used in conjunction with coloured gels to provide a display of any colour.

Characters are displayed in a 5 x 7 matrix, with display formats ranging from one line of 16 characters to four lines of 40 characters. The modules are CMOS and have very low operating currents.

Varitronix displays are available from Promark Electronics Pty Ltd, PO Box 381, Crows Nest, NSW 2065. Phone (02)439 5477.

Water resistant car speakers

Pioneer Electronics has announced the release of two new water resistant GF cone car stereo speakers: 60W models TS1635S and TS1645S.

By combining paper pulp, glass fibre and epoxy resin, the GF Cone develops less break-up than ordinary paper cone speakers to give lower distortion and wider frequency response. A by-product is that the GF Cone is water resistant. Thus there is no need to fit water deflectors when installing in doors.

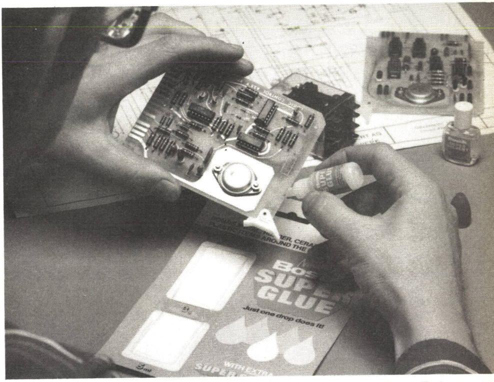
The two-way TS1635S is a flush-mount 16cm speaker which replaces the Pioneer paper cone TS1644. With its shallow mounting depth, 60W power handling capacity and frequency range of 40-20,000Hz, the TS1635S can serve as an ideal door or rear deck speaker for most vehicles.

The TS1645S is a three-way flush-mount 16cm speaker which provides a budget priced alternative to Pioneer's GF Cone TS1655 speakers, and is a worthy successor to the Pioneer paper cone TS168 speakers.

The frequency range of 35-20,000Hz for the TS1645S will make it a popular door or rear deck speaker. With power handling of 60W it is more than adequate for any car stereo system.

Further information from Pioneer Electronics, PO Box 295 Mordialloc, Victoria, 3195. Phone (03) 580 9911.

Bostik Super Glue and solvent pack



Emhart Australia Pty Ltd, makers of "Bostik" products, announce a new package and applicator for Bostik Super Glue. The new applicator squeeze pack dispenses one drop of superglue at a time on a surface to be bonded. The glue and applicator have many uses in the electronics industry.

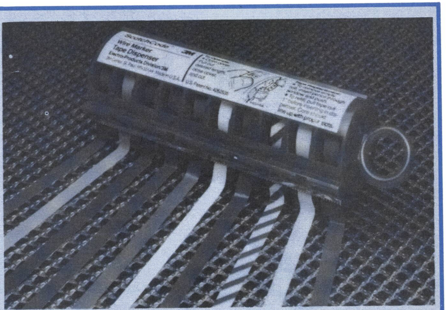
One of the major attractions of the handy pack is a 5ml bottle of non-toxic Bostik Super Solvent which comes with the three-gram plastic container of the Super Glue. Should the operator's fingers become bonded with the fast acting Super Glue, a few drops of the solvent will release the bonded skin painlessly, and the skin can then be washed in soap and water. Solvent must not be used to flush the eye should eye contact happen; only water should be used and a doctor called.

Satisfactory bonding of metals, glass, ceramics, natural and synthetic rubbers and plastics is essential to the electronics industry, and it is with these materials that the Bostik Super glue has the best results. After curing — 12 to 24 hours at room temperature — the colourless, odourless glue maintains its sheer strength in temperatures as low as minus 20°C and as high as 80°C to 100°C.

The company also markets a wide range of glues and adhesives for a variety of electronics industry applications.

Further information from Emhart Australia Pty Ltd, Bostik Division, PO Box 50, Thomastown, Victoria, 3074. Phone (03) 465 5211.

3M cable identification system



The 3M company has announced a second generation "ScotchCode" wire marker (identification) dispenser. The first generation unit, developed in the US, dispensed numbered or lettered rolls of adhesive tape and achieved immediate acceptance by electrical contractors, maintenance workers, and Telecom linesman.

The second generation unit retains the benefits of the "ScotchCode" Dispenser while offering the added option of a colour coding system for wire and cable identification. The pocket sized dispenser holds high quality electrical grade tape which conforms to the standard colours for wire and cable marking — blue, orange, green, grey, brown, white, red, yellow/green stripe, yellow and purple.

The flame retardant epoxy film tape will resist oil, solvents, dirt and extreme heat and has excellent conformability and adhesion to clean neoprene, hypalon, nylon and pvc insulation materials. The new coding system means that there is now a choice of three complementary "ScotchCode" marking systems — number, letters, and colours. When used together the three provide infinite flexibility for even the most complex identification tasks.

For further information about the "ScotchCode" wire marker dispenser, contact 3M Australia Pty Ltd PO Box 99 Pymble, NSW 2073. Phone (02) 498 9333.

Barcode data entry terminal

Barcode Technology has announced the release of a hand-held portable data entry terminal which can be connected to laser scanners and light pens or used alone for manual or automated data collection.

It is powered by nickel cadium batteries and high perfomance CMOS chips which make it ideal for remote applications in which data are keyed in manually, or for sites in which data are entered via a barcode wand or scanner. With CMOS chipmemory, retention is guaranteed even in the case of battery failure.

Using acoustic couplers data can be transmitted over a normal telephone line to a collection centre or downloaded direct to any host computer via an RS232C adaptor. A dot matrix printer prints 40 characters per line and runs off either mains power or a car cigarette lighter. The keyboard can be alphanumeric with up to 23 function keys, or numeric only with up to 13 function keys.

The display provides two lines of 5 x 7 dot matrix liquid crystal characters — 16 per line. Memory is up to 64K bytes — or 128K nibbles if data are numeric only — available in 2K or 8K byte increments. Peripherals available include the LS7000, a hand-held laser-based barcode scanner able to read information on labels without making contact.

Also available is a small contact barcode reader — an infrared light pen or optical wand. The reading tip has a protective metal sheath while the rest of the wand is made of high strength plastic.

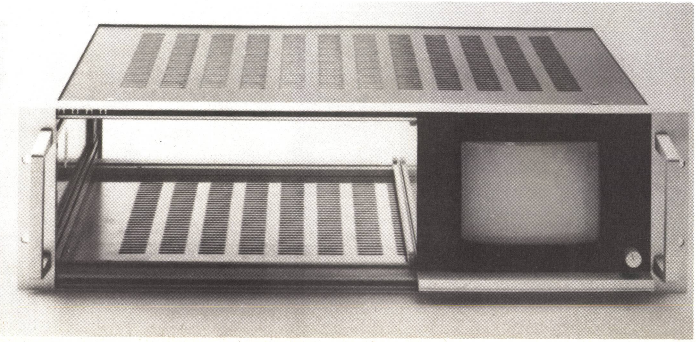
Further information from Barcode Technology Pty Ltd, PO Box 248, Enfield, NSW, 2136. Phone (02) 747 2244.

High resolution display monitor

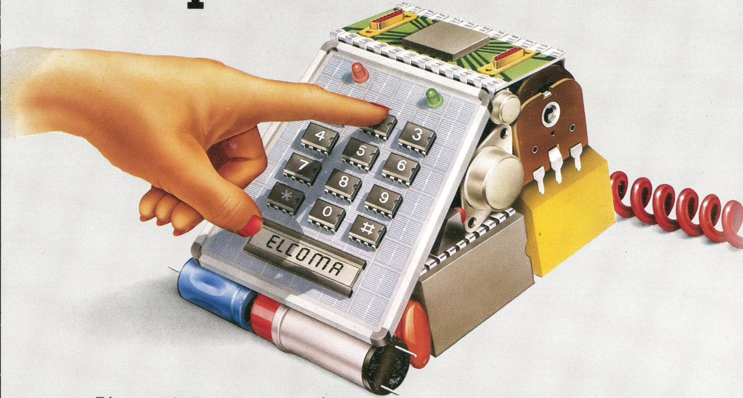
Energy Measurements has announced the realease of a new German-built 5-inch Display Monitor which is suitable for 19-inch rack mounting (3HE). The unit has provision for instant connection to TTL or BAS systems.

The unit operates at 25MHz and features a 125mm diagonal screen with high resolution display of 2400 characters (96 characters x 25 lines). The TK5 Europa Monitor is available in green and white screen and also as a freestanding unit. It is solid state and measures 129 x 230 x 113mm (W x D x H).

Further information from Energy Measurements, PO Box 90, Pymble, NSW, 2073. Phone (02) 449 9910.



Phone for telecommunications component innovations



Telecommunication equipment manufacturers face constant pressure for more and more user features. These pressures are accompanied by complex technical problems imposed by the highly sophisticated integration of business communications and information systems.

"New" equipment frequently becomes obsolescent, virtually from the first production run.

Elegant technical solutions, design flexibility and inherent reliability stem from the very latest "chip" and component technologies. So the long-term winners will be the companies who employ the most up-to-date and reliable electronic technology right from the start – moving their new designs smoothly into production.

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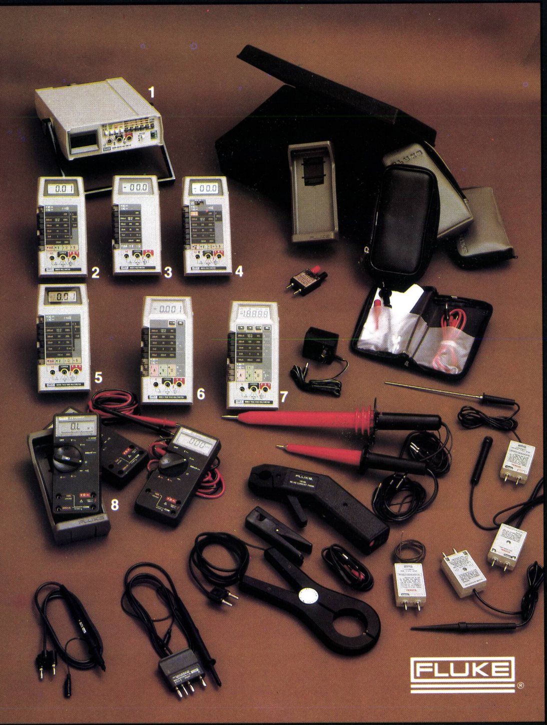

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8010A 8012A (similar to 8050A)

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2 8020B

• 3½ digit • 0.1% basic accuracy • Eight functions including conductance • Continuity beeper

3 8021B 8022B

• 3½ digit • 0.25% basic accuracy • Diode test • Continuity beeper (8021B only)

4 8024B

• 3½ digit • 0.1% basic accuracy • 11 functions including temperature with K type thermocouples • Peak hold on voltage and current • Logic detection and continuity testing • Audible and visible indicators

5 8026B

• 3½ digit • 0.1% basic accuracy • True RMS to 10kHz • Conductance to 10,000Mohm • Diode test and continuity beeper

6 8062A

• 4½ digit • 0.05% basic accuracy • Similar to 8060A without counter and dB • Relative reference • True RMS to 30kHz

7 8060A

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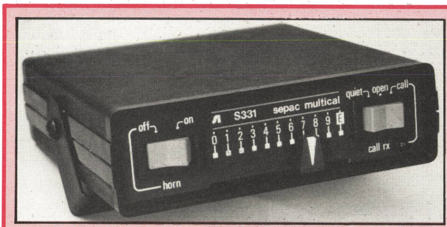
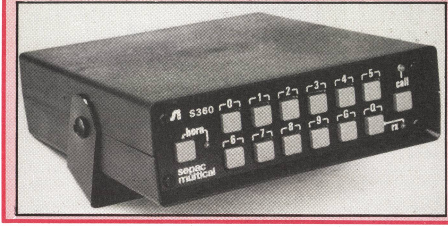




Mobile radio selective calling systems

Sepac Industries offer two low cost mobile radio signalling units which provide an economical mobile to mobile radio selective calling network. The S331 provides a mobile operator with the facility to selectively call up to 10 stations by setting a slider switch. Facilities include the use of the vehicle horn as an external alarm, flashing LED and audible beep to alert the called driver, individual addressing of mobile units, and auto acknowledge.

The S360 is an advanced version of the S331, which, in effect allows any vehicle to operate as a base station. Features include mobile selective calling of up to 1000 outstations, individual addressing of called mobile units, auto acknowledge of receipt of addressed calls, external horn alarm, etc.

Both units interface directly with most brands of mobile radio and are compatible with the Sepac range of Selcal console and mobile units.

Further information from Sepac Industries (Australia) Pty Ltd, 134 Beach Street, Frankston, Victoria, 3199. Phone (03) 781 3144.

RIFA high efficiency DC/DC converters

Marketplace Communications Pty Ltd announce the availability of a range of DC/DC converters manufactured by Rifa of Sweden. The series comprises eight different DC/DC converters, all having the same mechanical design. Five of the converters are fed with 48V and the others with 24V. Each group includes a converter for three output voltages, and the first group also has one for two output voltages. All the remainder provide a single output voltage.

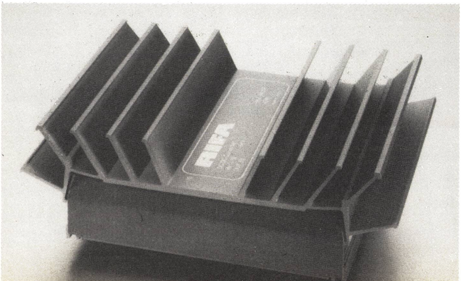
The converters can be connected in parallel, they have transient protection on the supply side, current-limited output, slow start and external start/stop function, and the output voltage is adjustable to within ±10%. The use of high conversion frequency ensures small dimensions. The power modules operate at 300kHz as against the 30-40kHz commonly used in conventional converters.

The converters are produced in two versions, one for mounting on printed circuit boards, and one for individual mounting (chassis version). In the basic printed board version the ceramic substrate with the components is mounted on a heatsink profile with an aluminium lid, which protects it against mechanical damage. The 40W power module is also equipped with an extra heatsink section which is snapped on to the heatsink profile.

The chassis version has an adapter mounted on the heatsink profile, and this version of the 40W module does not need any extra cooling.

The 48V input versions have power rating from 25W to 40W with output voltages, either singly or in combination, of 5V and 12V, including ±12V. The 24V input versions have a similar range. The actual input voltage can range from 39 to 64V for the nominal 48V versions, and from 19 to 35V from the 24V versions. Efficiency is given as 80%.

Futher information from Marketplace Communications Pty Ltd, 31 Robinson St, Dandenong, Victoria, 3175. Phone 793 5122.



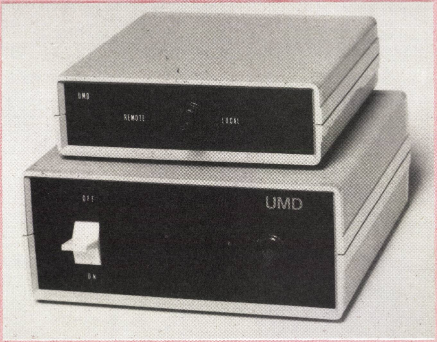
Computer display expander

The expanding field of personal computer training, sales, promotion, and education has prompted a Melbourne based company, Unique Micro Designs, to develop a display expander system. This facilitates the distribution of video information to several monitors from a single computer. Two systems are available: passive splitting, and an active master/slave daisy chain network.

Low cost passive splitting can be used when a maximum of four monitors are to linked to a personal computer, in a star configuration, involving distances of less than three metres.

Active transmission is available for longer distances and/or larger numbers of monitors. Slave units may be connected to a monitor, personal computer, or linked daisy chain fashion to the master personal computer.

The system has proved to be an excellent aid for organisations providing "hands-on" microcomputing courses. The ability of the students to switch the display from their own systems' output to what is displayed on the teachers' VDU is quite useful in the classroom situation.



Further information from Unique Micro Design Pty Ltd, 4 Robinlee Ave, East Burwood 3151. Phone (03) 233 4817.

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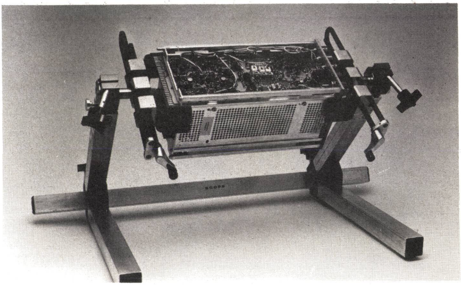
Versatile chassis holders from Scope

The Panavise division of Scope Laboratories has released two new chassis holders which pivot horizontally with friction brake and positive lock detent. Both models are portable and capable of accepting chassis up to 450mm wide. The pivot centre height is 225mm from the bench top.

One model (602) has twin self centering clamps opening to 225mm. the other model (601) has scissor clamps with swivel jaws to accept odd shaped chassis. For safety, a positive lock detent is visible while rotating the chassis, with a visual indicator showing when the safety latch is engaged. An all-metal friction brake on each bearing is also fitted.

Further information from Scope Laboratories, PO Box 63, Niddrie, Victoria, 3042. Phone (03) 338 1566.



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REVIEWED E.A.Sept

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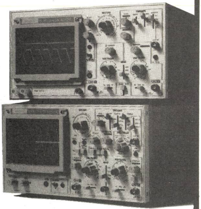
- Sweep Mode: NORMAL, AUTO, SINGLE, DELAY
- Trigger Delay: INTEN'D, DELAY'D; 1us - 100mS
- Trigger Source: INT, LINE, EXT, EXT/10
- X-Y Operation; & X-Axis modulation



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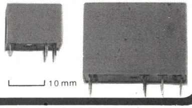

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Toss out those rats nests and get on with the job!

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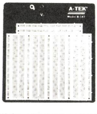

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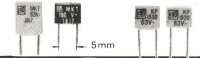

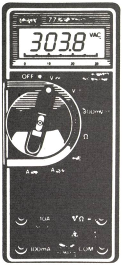

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Thermocouple probe for your digital multimeter

Do you need a thermocouple probe for your multimeter but cannot afford the commercial models? This probe suits any digital multimeter and can also be used with analog multimeters.

by LEO SIMPSON Design by BOB FLYNN

Anyone who designs and builds amplifiers or power control circuits needs a means of measuring temperatures over a wide range. A thermocouple probe which can be connected to a digital multimeter is an attractive proposition but commercial probes can cost $200 or more. This EA design will cost considerably less than that.

Temperature range

This design uses an iron-constantan thermocouple which can measure temperatures up to 350°C on a continuous basis or up to 400°C intermittently. The lower temperature limit is about −17°C, as set by the circuit itself.

This large temperature range will allow measurement of body temperatures of all power semiconductors and wirewound resistors. The probe will also have applications in automotive engineering and in many laboratory situations.

At the same time, the minimum temperature limit of −17°C will be suitable for checking freezers and refrigerators.

Accuracy

Let's immediately put accuracy into perspective. Thermocouples are not particularly linear devices. That is to say, their temperature coefficient is not constant throughout their operating temperate range. An iron-constantan thermocouple is one of the more linear types in this respect but unless a complicated compensation circuit is employed, the best accuracy that can be expected is within about ±3.5% over the whole range.

In other words, just because this thermocouple probe is mainly intended for use with digital multimeters, we make no claim to have achieved typical DVM accuracy. The best you will achieve is within about 2°C over the range from 0°C to 150°C. For most applications that is more than adequate.

Output voltage

This thermocouple probe is really a temperature to voltage converter. It has an output which is zero at 0°C and varies at the rate 10mV/C°. This makes it suitable for all digital multimeters and analog multimeters with an input impedance of 10MΩ.

The electronic components of the circuit are housed in a small plastic zippy box measuring 83 × 55 × 32mm. This is fitted with two banana jacks on one end to plug directly into any digital multimeter. The unit is powered from a single 9V battery.

Now let's discuss the theory of operation. A thermocouple is made by joining wires of two different metals, as shown in Fig. 1. The output voltage is proportional to the difference in temperature between the measuring junction and the reference junction. The constant of proportionality is known the Seebeck coefficient and ranges from $5\mu V/C°$ to over $50\mu V/C°$ for commonly used thermocouples.

How do we use this Seebeck effect to directly measure temperatures? One way is to maintain the reference junction at a constant 0°C (in an ice bath). This means that the thermocouple output will be zero when the measuring junction is at 0°C and we will not have to worry about what the ambient temperature is.

Well, ice baths are nice and reproduceable but they are not the most

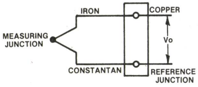


Fig. 1

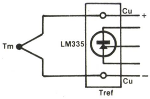


FIG. 2

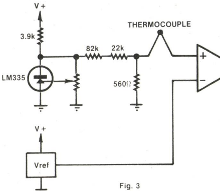
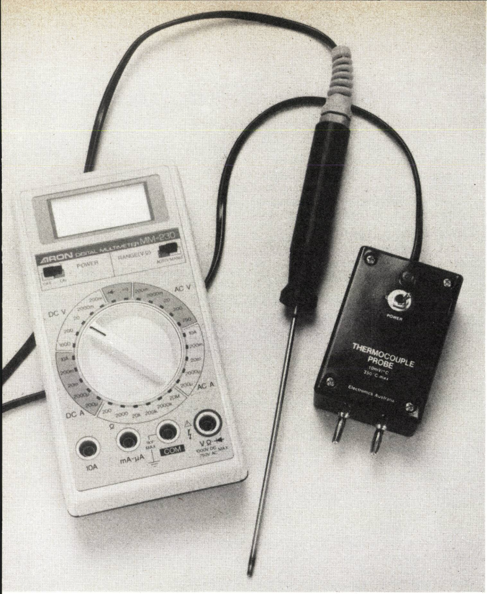


Fig. 3

Fig. 3: basic thermocouple probe circuit. The LM3535Z provides reference junction compensation.



The Thermocouple Probe plugs directly into your digital multimeter and can measure temperatures from −17°C to +350°C.

We estimate the current cost of parts for this project to be

$25-$28

This includes sales tax but does not include the cost of the thermocouple which will vary according to type.

convenient way of providing a fixed reference. A more convenient method is to add a compensating voltage to the measuring circuit so that the reference junction appears to be always at 0°C when, in reality, it is floating up and down at the ambient temperature.

Our circuit has this reference junction compensation. It takes the form of a National Semiconductor LM335Z precision temperature sensor. This semiconductor device generates a voltage which is directly proportional to the absolute temperature. Fig. 2 shows that the LM355Z is held at the same temperature as the reference junction.

The method of compensation works like this. The output of the LM335Z is adjusted and divided so that it looks like another thermocouple, as far as the circuit is concerned. Its output is connected in series with the measuring thermocouple which is connected to an op amp measuring circuit. At the same time, another reference voltage is used to

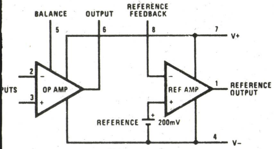


Fig. 4: the LM10C contains a precision voltage reference, an adjustable buffer, and a high-quality op amp.

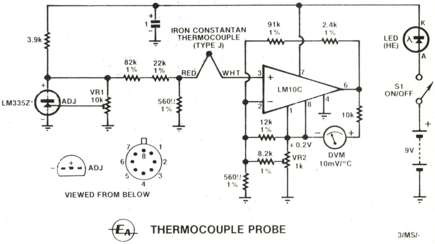


Fig. 5: final circuit for the Thermocouple Probe. Note that the meter is connected to the reference output, pin 1, so that temperatures below 0°C can be measured.

Thermocouple probe for your digital multimeter

buck out the absolute voltage generated by the LM335Z.

The method of connection is shown in Fig. 3. It works like this. When the thermocouple is at ambient temperature it generates no voltage. But the LM335Z does generate a voltage.

Now the interesting point about the LM335Z is that it can be calibrated to have less than 1°C error over a 100°C temperature range by setting it give 2.932V at 20°C.

If we then feed the LM335Z output voltage through the divider (82kΩ + 22kΩ + 560Ω) the output at 20°C is then 15.7mV and it will change at 53.5μV/C° which is the same as the Seebeck coefficient of the thermocouple.

So now we have two temperature-dependent voltage sources connected in series to the non-inverting input of the op amp in Fig. 3. Thus the output of the op amp will be directly proportional to the temperature at the measuring junction. There will be no need to correct the measured temperature by adding in the ambient temperature; the circuit has done that for us.

One problem remains though. The LM335Z has an output of 14.6mV at 0°C. This means that the op amp will not have a zero output at freezing point which is what we want. We need to cancel out the effect of that 14.6mV "offset" from LM335Z at 0°C. This is accomplished by feeding a fixed 14.6mV to the inverting input of the op amp.

The output of the op amp will now be zero at freezing point and the output voltage will be directly proportional to the temperature in degrees Celsius.

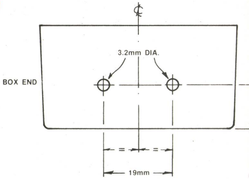
Op amp requirements

The op amp we require is rather special. Ideally it should operate from a single low voltage supply, have a low current drain to conserve the battery and have an especially low drift. In addition, we also have the requirement of a fixed voltage reference which is needed to cancel out the LM335 offset.

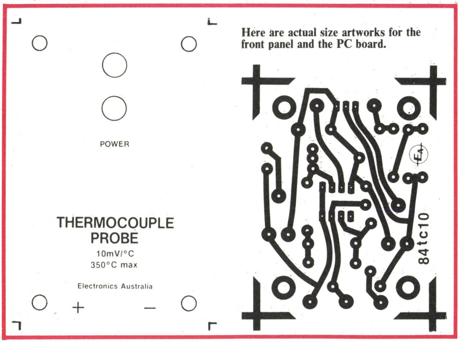
It so happens that there is one op amp which meets all these requirements neatly, including having an inbuilt voltage reference. It is the National Semiconductor LM10C. This is described by the manufacturer as a monolithic IC consisting of a precision voltage reference, an adjustable reference buffer and an independent high quality op amp.

The LM10C will operate from a single supply voltage ranging from a low of 1.1V up to 40V, with a current drain of only 300μA (typical). Its complementary output stage will swing to within 15mV of the supply terminals.

The inbuilt voltage reference is 200mV and this may be amplified by the buffer if necessary.



Above: mounting details for the banana jack plugs. At right is the wiring diagram. Take care with the orientation of polarised parts.



Here are actual size artworks for the front panel and the PC board.

The circuit

Now lets have a look at the final circuit which uses the LM10C. The components associated with the LM335Z have already been discussed but the way in which the internal voltage reference is used needs explanation.

The reference output of the LM10C is set at 200mV by operating the internal buffer stage as a unity gain amplifier. This is accomplished by connecting pin 1 to pin 8 (see the function diagram of the LM10C, Fig. 4.) VR2 sets the input voltage to pin 2 to balance out the 14.6mV from the LM335Z (at 0°C).

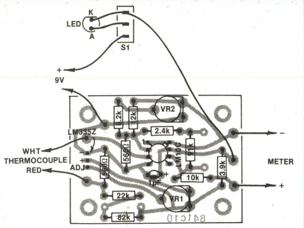
There is another wrinkle in the way in which the meter is connected. Note that it is not connected to the 0V rail but to the reference output, pin 1. This means that the negative side of the meter is jacked up by 200mV above the 0V rail. This means that pin 6 of the LM10C should also be at +200mV when the thermocouple is at an ambient temperature of 0°C. In fact VR2 accomplishes this.

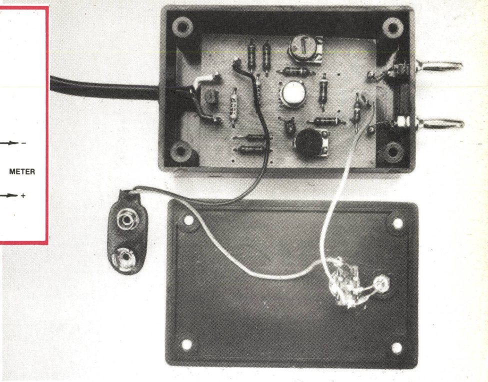
The reason for tying the negative side of the meter to +200mV is so that temperatures below 0°C can be measured. If the meter was tied to 0V it would not be able to register temperatures down to 0°C because the LM10C cannot swing its all the way down to 0V.

The voltage gain of the op amp is set to 187 by the feedback resistors, 91kΩ and 2.4kΩ in series. This means that the thermocouple voltage coefficient of 53.5μV/C° is converted to 10mV/C° by the circuit.

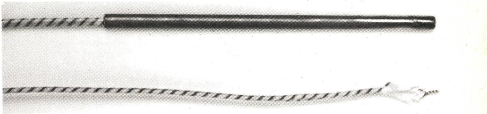
Current drain of the circuit is close to 1.5 milliamps and it should operate reliably down to a battery voltage of 5V. With intermittent use we estimate the battery life to be about 300 hours.

A high brightness LED is connected in series with the battery supply to give a pilot light. This scheme is more economical than separately powering the LED from the battery supply, yet provides sufficient LED brightness.





View inside the prototype. Use enclosed cermet trimpots for good stability.



Depending on your application, you can use either a probe-type thermocouple or a simple welded junction thermocouple (eg, for monitoring heatsink temperature).

PARTS LIST

- 1 zippy box, 83 × 55 × 32mm, with plastic lid
- 1 label to suit
- 1 PC board, 60 × 45mm, code 84tc10
- 1 216 9V battery plus clip connector
- 1 SPDT miniature toggle switch
- 1 thermocouple probe (see text)
- 1 LM10CN op amp
- 1 LM335Z temperature sensor IC
- 1 high brightness red LED plus bezel
- 1 1µF/35V tantalum capacitor
- 6 PC pins
- 2 banana jack pins

Resistors (¼W, 1% unless specified)
1 × 91kΩ, 1 × 82kΩ, 1 × 22kΩ, 1 × 12kΩ 1 × 10kΩ/5%, 1 × 8.2kΩ, 1 × 3.9kΩ/5%, 1 × 2.4kΩ, 1 × 560Ω, 1 × 10kΩ cermet trimpot, 1 × 1kΩ cermet trimpot

Construction

All the circuit components with the exception of the LED are mounted on a small PC board measuring 60 × 45mm and coded 84tc10. Assembly is a simple matter as only a few parts are involved.

Two versions of the LM10C are suitable for this circuit. They are the LM10CH, the metal package, or the LM10CN, the dual in-line plastic package. If the metal package is used its leads should be bent to suit the in-line lead configuration and pushed down onto the board as far as possible.

Note that most of the resistors are specified with 1% tolerance and so will have five colour code bands instead of the usual four. Read them carefully before installing the resistors.

Both trimpots should be the enclosed "cermet" variety for good stability.

Note that the PC board should be installed in the zippy box and the thermocouple connected before any checks can be made. Make sure the thermocouple leads are well-tinned before attempting to solder them to the PC pins on the board.

Output connections are made to banana jack pins (fitted with nuts) which are fitted to the zippy box at ¾-inch centres (19mm) to suit most digital multimeters.

We fitted the high brightness LED into a red bezel to make an effective pilot light for the unit. The LED is wired across the SPDT switch as shown in the diagram.

By the way, all the parts for this project may be obtained from Geoff Wood Electronics, 656a Darling St, Rozelle NSW 2039. Phone (02) 810 6845.

Calibration

This is a simple procedure. Ideally you need a laboratory grade thermometer plus your digital multimeter. First step is to note the ambient temperature in the vicinity of the thermocouple junction. Then VR1 should be set so that the voltage across the LM335Z is equal to 2.732V plus 10mV multiplied by the ambient temperature.

For example, if the ambient temperature is 15°C the voltage across the LM335Z should be 2.732V plus 150mV which equals 2.882V.

Now plug the unit into your digital multimeter which should be switched to the 2V range. Adjust VR1 to give a reading on the DMM which is the product of the ambient temperature multiplied by 10mV/C°. For example, if the temperature is 21°C the voltage reading should be 210mV.

And that's it. If you wish you can now check the thermocouple at reference temperatures of 0°C and 100°C using ice and boiling water respectively but it should only confirm that the system is accurate to within about 2° or better

Continued on page 117

§§

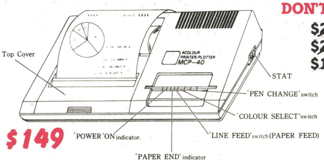
JAYCAR

SENSATION!
SCOOP PURCHASE
of 4 COLOUR PRINTER/ PLOTTERS!!

Jaycar has done it again! We have made a scoop purchase of 4 colour printer/plotters at a never-to-be repeated price!! The SAME printer has sold elsewhere for up to **$299** but currently sells for as low as $169. At $169 it is an absolute bargain! (See specs). Now Jaycar can offer you the SAME printer for $149!!How do we do it? We have bought BELOW IMPORTERS COST and have passed the SAVINGS on to you!

QUANTITIES STRICTLY LIMITED. We have less than 80 pcs in stock at the time of going to press. To avoid disappointment, we suggest that you ACT QUICKLY.

The printer/plotter is supplied with mains lead, a roll of paper 114mm x 55m long (4.5" x 180') and a set of 4 pens (black, blue, red & green). Spare rolls and pens are available from other major electronic suppliers and for a short time, us.



DON'T PAY

~~$299~~
~~$229~~
~~$169~~

$149

Cat. XP-4605

SPECIFICATIONS

Printing/Plotting System	*Ball Point Pen, 4 colour*
Plotting Speed	
(Horizontal)	*52mm/sec (2.05ips)*
(Vertical)	*73mm/sec(3.80ips)*
Printing Speed	*12 characters per second*
Resolution	*0.2mm/step(0.00787 inch)*
Effective Plotting Range	*96mm (3.804 inch) x axis Divided into 480 steps (No limit in y direction)*
Characters per Line	*80 or 40 (Text Mode) (Determined by Software in Graphics Mode)*
Accuracy (repetition)	*0.2mm max*
(Movement)	*0.3mm max*
(Distance)	*0.5% max (X-axis) 1% (Y-axis)*
Dimensions	*276mm wide (8.4") 174mm deep (8.64") 68mm high (3")*
Pen Life	*250 metres (825 feet)*
Parallel Interface	*8-bit parallel. Uses BUSY handshaking, STROBE, and ACKNOWLEDGE*
Selectable Modes	
Self Test	*Prints 96 ASCII character set in 4 colours*
Text Mode	*Normal Serial and Parallel Printing*
Graphics Mode	*Image Plotting using the Various commands*
Power Supply	*200-240V AC*

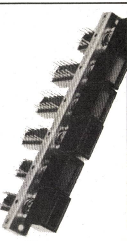
Comprehensive instruction manual with typical graphics programs supplied.

Cat. XP-4606 Spare Paper Rolls $3.30
Cat. XP-4607 Set of 4 Pens $7.50

SUPER SWITCHBANK BARGAIN!

Famous German made "Schadow" push-push switch bank set! Each bank consists of six (3xDPDT, 3x6PDT) switches. The switches are not interlocked and can be removed from the carrier strip. A major feature is the fact that each switch is fitted with a mechanical indicator button. When the switch is depressed, a bright coloured rectangle appears in a clear window at the front of the switch button. This obviates the need for a separate indicator LED. Colours are 2 x white, blue, green, red & yellow. Very pretty! It would cost around $10 in large quantities to have a set like this made. You never know when you will need a pushbutton like this. (Remember it can be dismantled to component parts easily). We only have a small quantity so act quickly!!

Cat. SP-0790 ________________ **ONLY $2.95**



BARGAIN! 12V DC 400mA Plug Pack

WOULD YOU BELIEVE a quality Australian made Ferguson plug pack for LESS THAN the cost of a Taiwanese import?

Yes but only for October and only at Jaycar. You guessed it another BELOW COST SCOOP buy. A 300mA plug pack will cost you around $14-15 (admittedly switched volts range), so you would expect to pay more for a powerful 400mA unit right? WRONG!

The MP-3013 is also supplied with a very handy 2.8 metre long cord with twisted wire leads at the end. Now the price! For October only you can grab this fantastic bargain for only **$6.95!** That's right almost ½ normal cost! OCTOBER ONLY - Orders received after October will not be recognised.

Cat. MP-3013 __________ **$6.95**

NOW OPEN UNTIL 4 PM SAT. CITY & CONCORD!

MICROBOTS® BACK!

We have secured another shipment of the two most popular Micro Robot kits.

SEE REVIEW IN EA MARCH '84!

PIPER MOUSE

This 'microbot' is powered by 2 DC motors that drive wheels. When special ultrasonic whistle is blown, the unit goes left, right, straight ahead according to your command. Complete, including perspex dome cover! Be a Pied Piper!

Cat. KJ-6680

$34.95 - SAVE $5

MEMOCON CRAWLER

This robot is controlled by a keyboard (which is supplie keyboard plugs into the robot. Up to 256 discrete com can be entered into the robots memory (RAM). The ro then move according to programmed instructions. Ligh a buzzer can also be programmed to operate as well

Cat. KJ-6686

$69.95 - SAVE $10

SMOKE DETECTORS

The consumer flop that should never have flopped!

One of the greatest consumer flops of the last decade was the ionization-type smoke detector.

Even though it was a brilliant product (see box), is reliable, compact, easy installation, fail safe etc., it just did not sell. Apparently human nature being what it is finds safety-oriented products just not worth the investment however modest. We all know, for example, that accidents and fires never happen to **US!!**

We all know also, that smoke is the greatest killer in a fire. Many fires smoulder for hours before catching alight and causing physical damage.

The US market research gurus thought that a cheap, compact smoke detector would be a mass consumer item. But boy, were they wrong! When they sold for **$49.50** no one wanted them. The price fell to a very reasonable **$29.99** and still they stayed on the supplier's shelves. Jaycar was called in.

We have now been instructed to sell them for less than ½ this amount!!

Now no-one, no-one has an excuse. You owe it to yourself, your children and family to afford them this simple, reliable and low cost protection. If you are a Hotel, Motel or Lodge operator don't miss this wonderful opportunity to install smoke detectors at a never-to-be-repeated price.

Cat LA-5090

(Were advertised earlier this year at $19.95 each but originally sold for $49.50).

TECHNICAL

For those unfamiliar with the product, a brief description: A minute speck of the rare element Americium 241 is enclosed in a sealed metal chamber within a compact plastic case that contains control electronics, battery and solid state alarm. A very small ionised field is set up within the chamber. When smoke enters the case and then the chamber, the chamber changes electrical state and the external circuit switches on the alarm. The chamber detects down to very low smoke levels. The electronics circuit is run by a 9V battery. When the battery is getting towards the end of its life the circuit automatically gives you up to two weeks warning by emitting distinct beeps.

If the idea of a radioactive device concerns you, don't worry because this device emits less radiation than your average clay-fired housebrick!!

The "Smoke Sentry" is completely self-contained, is round and measures a compact 115mm diameter and 40mm deep. Fixing screws (even masonry plugs!) are provided as well as 9V battery and very comprehensive instruction manual.

ONLY

$14.98

§§§§§§§§§§§§§§§ **WAREHOUSE MOVING FROM OCT 1st TO 7/9 RAWSON ST. AUBURN 2144** §§§§

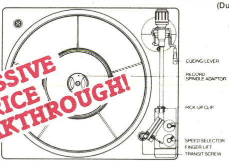
LECTRONIC BELT DRIVE
URNTABLE BSR QUALITY

Jaycar has made a sensational scoop purchase of B.S.R. belt drive turntables from England at below manufacturers cost!

Two models available AA-0290 works from 9-12V DC and the AA-0292 from 240V AC (includes 12V 400mA adaptor). The DC motor drive is electronically controlled.

PECIFICATIONS:

- Dimensions 330(W) x 285(D) x 60(H)mm overall
- Platter diameter 280mm
- 2 speed - 33 & 45 rpm (internally adjustable)
- Pick-up arm counterbalanced type with cueing facility
- Pick-up ceramic (stereo) with diamond stylus
- Turntable operation - auto stop, will return to rest automatically. Turntable chassis is sprung on all corners with transit screws & clips ★ Weight 1.5kg
- Output stereo RCA sockets underneath unit



MASSIVE PRICE BREAKTHROUGH!

(Due to the weight of the unit post and packing is $5 NOT $4.50)

Check the price! Cat. AA-0290
(Requires 9-12V DC

ONLY
$29.95

240V version -
(includes 12V 400mA adaptor)
Cat. AA-0292

ONLY $39.95

★ SEE OUR OTHER ADS FOR HI FI SYSTEM ★

★ NEW ★
CQAM STEREO DECODER KIT

Ref: EA Oct 1984

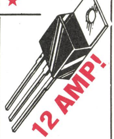
of parts for this project including PCB, 10uH choke, C13020 IC.

KA-1555 ________ **ONLY $19.95**
(Whistle filter coil extra)
Cat. EE-3814 $19.95

ANOTHER BARGAIN
CHEAPER THAN ELECTRETS

Quality West German made dynamic mic inserts. You can feel the quality by the weight of one in your hand! Not too much in the specification dept. except that we know that they are **GOOD!!**

Cat AM-4015 **$1.50 ea (1-9)**
10 or more $1.25 ea



BARGAIN OF THE CENTURY!!

How do we do it?
Another BARGAIN!!

Once again, Jaycar has secured a massive below-cost scoop purchase. This time a nifty combination VHF/UHF television tuner assembly! We **dare not mention** the **famous Japanese brand** of this quality assembly!

- *Brand, spanking new*
- *Separate VHF rotary tuner*
- *Separate UHF rotary tuner*
- *All knobs & wiring INCLUDED!*
- *Attractive front panel fascia included!*
- *Circuit diagram included!*

Be quick to secure one of these as we only have **70** pieces for sale.
Cat DM-9004

ONLY $69.95 HURRY!

---

400 VOLT TRIAC BARGAIN!! Yet another Scoop Purchase!!

Genuine 'Motorola' brand 2N6343 12A 400V Triac. TO-220 case. Equivalent to GE SC141D which sells for $1.65. (As used in the Musicolor). Cat. ZX-7140

Only $1.50 each or pack of 10 for $10

SENSATIONAL DEALS ON
3-WAY SPEAKER SYSTEMS!!

8" 3 WAY SYSTEM

Superb 8" woofer with foam surround suspension and heavy magnet assembly with sealed back midrange and tweeter. System impedance 8 ohms. Power handling 40 watts rms. Crossover capacitors and connecting diagram and recommended 8" cabinet detail drawing supplied.

Cat. CS-2453 (2 required for stereo) **$29.95/set**

10" 3 WAY SYSTEM

Once again, a high quality 10" woofer with higher power, sealed back midrange and tweeter. System impedance 8 ohms. In addition a quality Pioneer 3-way crossover is provided at no extra charge. Connection instructions are also provided as well as recommended 10" cabinet plans.

Cat. CS-2454 (2 required for stereo)
INCLUDES PIONEER 3-WAY CROSSOVER!! **$39.95/set**

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ANUFACTURER'S
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ONLY
$125
COMPLETE
MASSIVE SAVING
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FULL 90 DAY WARRANTY

AS REVIEWED
OCT '82
EA (p.26-28)
ETI NOV '82 (p.26)

CAT. XC2010

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or by mail order to
Jaycar
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Jaycar Sydney (City)	264 6688/267 1614		
Jaycar Concord	745 3077		
Jaycar Carlingford	872 4444	**Rod Irving**	
Jaycar Hurstville	570 7000	**Melb A'Becket St**	(03) 347 9257
Zap Electronics	Parramatta	**Northcote**	(03) 489 8131
	Hornsby	**Altronics Perth**	(09) 328 1599

At $199 the Voyager Car Computer represented absolutely outstanding value for money. No one else had such a low priced **FULL FUNCTION** car computer. The Voyager is the only low-cost unit that will give you full consumption (the most important feature in a car computer) in both metric litres 100km **AND** good old **MILES PER GALLON!**

At $199 many, many hundreds have been sold. **NOW** you can grab one **absolutely complete** for only $125 — a saving of 37% or $74!

The Voyager comes absolutely complete with all fitting hardware — even down to a roll of insulation tape! Installation generally takes between 4 and 6 hours depending on vehicle

Spare Flow Sensors: Jaycar will be supporting this product for many years to come. To avoid problems changing cars, why not buy a spare fuel flow sensor? They are about the only things that wear out

ONLY **$29.50**
Cat. XC2036

SEE OUR OTHER ADS FOR ADDRESS PANEL AND OTHER INFORMATION

The Serviceman

A story with a kick in it

Why is a modern TV set power supply like a motor car engine? No, that's not a conundrum from Simon Townsend's Wonder World, nor am I trying to be facetious. Both devices have one very important characteristic in common, something which my main story this month makes clear. Curious? Read on.

The story concerns a late model 30cm Rank Arena colour set. It is interesting not so much for the actual fault — which turned out to be quite trivial — than for the job of finding it. The relevant circuitry is also interesting and, while fairly common these days, is in a form which I have not dealt with in much detail in these notes before.

The basic complaint about the set was that, at times, it simply would not function at switch-on; or, as the owner put it, "it wouldn't start". In fact, his description was more accurate than he probably realised. For my part, I would have preferred it to be a permanent fault, rather than intermittent.

As it turned out, I needn't have worried.

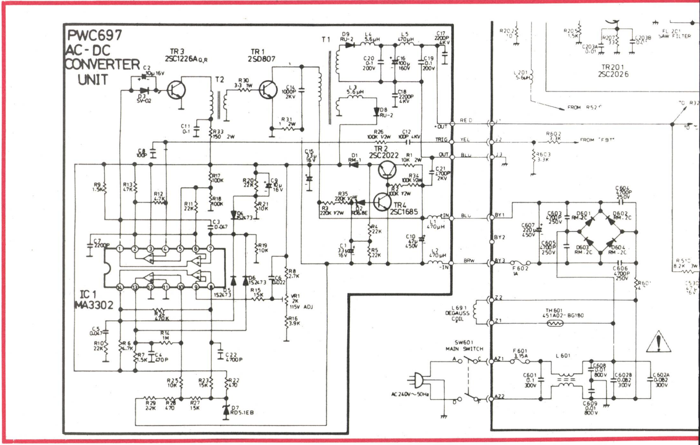
In greater detail the set was a C1210, a model which is only some three or four years old, and one which I had not encountered before. And, as with any new set, this meant that it took me a little while to find my way around both the circuit and the chassis. This was particularly so because the circuit is quite different, and more in keeping with modern trends than the older Rank Arenas with which I have been acquainted to date.

In fact, the set was so new to me that I did not even have a circuit of it but, fortunately, the owner had acquired one and brought it along with the set. (I promptly made a note to fill the gap in my files.) One glance at it made me realise that it was nothing like the Rank Arenas of old, and I took some time going over the circuit to get the feel of it.

In many ways it follows what is now fairly common practice but, of course, with its own individual twists. For this reason I think a broad discussion of the circuit, particularly the power supply, is justified. It is a transformerless arrangement, with the mains being applied directly to a bridge rectifier, the output of which is filtered by a 220μF electrolytic (C607), and which sits at about 320V under normal operating load.

This forms what might be termed the primary DC supply, but the main HT rail

The main supply rails are derived from the line output stage, which also powered from one of these rails!



of 115V, the picture tube heater supply, and several low voltage supply rails, are all generated at line frequency (15,625kHz), then rectified and filtered as required.

An apparent contradiction in circuits of this type is that the line frequency generating circuit also operates from a supply rail derived in this manner. In this respect, the arrangement resembles an internal combustion engine; it keeps running only by reason of the fact that it is running in the first place.

If it stops it cannot start again of its own accord; it needs an external kick to get it started.

In this circuit, two main supply rails, including the 155V rail, are derived from a transformer (T1), the primary of which is driven by a 2SD807 power transistor (TR1) operating at line frequency. Collector voltage for this transistor comes directly from the mains bridge rectifier at 320V. The base is driven via another transformer (T2) by a 2SC1226A transistor (TR3), the base of which is driven at line frequency.

This line frequency comes from pin 1 of an MA3302 IC (IC1) which functions basically as a voltage regulator. Line frequency from pin 4 of the line output transformer (T502) is fed into IC1 at its pin 4.

Transformer T1 has two secondary windings, the larger one providing the 115V rail via diode D9 and associated filter capacitors and chokes. The smaller winding provides an 8.8V rail via diode D8 and filter capacitor C15.

So how does the system derive its own "kick start". This is simple and quite ingenious. The horizontal oscillator, along with a number of other functions, is provided by an AN5410 IC (IC401) which operates from a 12V rail. This 12V rail is derived from the line output transformer (pin 2) via D505 and associated filter components. It feeds pin 8 of IC401 via an isolating diode, D608, with further filtering by C530, a 47μF electro.

But there is another circuit feeding this electrolytic. This comes from the 115V rail via an 8.2kΩ 3W resistor (R510). At switch-on, voltage from the bridge rectifier is applied to the collector of TR1 via the primary of T1 and, by reason of the 1000pF capacitor, C14, creates a momentary current pulse in the primary and thus generates a voltage in the secondary.

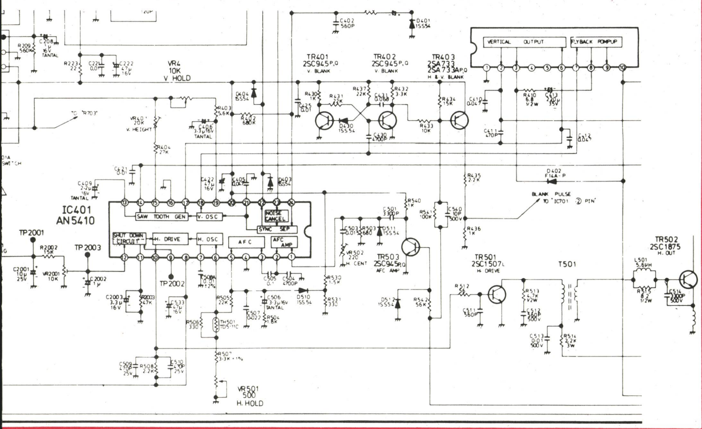
This is sufficient to charge C530 to approximately 12V and thus briefly energise IC401, the pin 10 output of which drives the horizontal drive transistor TR501. This in turn drives the horizontal output transistor, TR502, and thus energises the horizontal output transformer. Once this happens all the normal operating voltages are generated and the system becomes self sustaining.

If you found all that a bit hard to digest, don't be too disheartened; it does take some effort to follow it. On the other hand, it really is necessary to understand this kind of circuit if one is to service it effectively.

So, having digested the circuit more or less along the lines I have just described — and I didn't find it easy either — I decided to switch it on and see what happened. In fact, it worked first time, and I took the opportunity to make various voltage measurements and to check them against the circuit and against my own analysis of how the circuit worked. As far as I could determine, everything was exactly as it should be.

Subsequently, I was glad I had made these measurements because that was the one and only time the set functioned until I located the fault. The next time I switched it on it was completely dead. A basic problem with any feedback circuit of this kind — because that is what it is — is to determine just where the break is occurring.

My first thought concerned the starting pulse just described. Was it being generated? I stoked up the CRO and connected it to the 115V rail, then flicked on the main power switch. The CRO responded immediately with a brief but quite substantial deflection. There seemed no doubt that the kick voltage was working. I was even able to confirm this with a meter, which also kicked well



up the scale at each switch on.

So what next? Could there be a fault in IC401? There could be of course, but how to confirm this, or otherwise, was another matter. I didn't have a spare and, in any case, with 24 pins to be unsoldered, I didn't fancy tackling the job on a mere "might be" basis.

Then, for once, the brain earned its keep with a quite practical idea. Not a new one, but one I hadn't used for a long time. Suppose, without energising the set, I were to isolate the supply rail for IC401 (but leaving C530 in circuit) and energise it from a separate external supply at around 12V. I should then be able to determine, with the CRO, whether it was generating line frequency voltage at pin 10.

No sooner said than done. In the event the external power supply was nothing more elaborate than a 216 type 9V battery which happened to be handy. Having connected it I checked pin 10 with the CRO and found a beautiful train of pulses exactly in accordance with the waveforms shown on the circuit. This was traced as far as the collector of TR501, the horizontal drive transistor.

So that seemed to clear that part of the circuit but, at this stage, I had no way of knowing whether there was a fault further down the line in the line output stage, the line output transformer, or any of the associated minor components. The only clue I had was that the set had worked once for me, which seemed to rule out any catastrophic failure in this area.

Getting close

Then I had another idea. If I continued to drive IC401 from the battery, but turned the set on, could I bypass the line output stage by feeding a horizontal signal from pin 10 of IC401 directly to pin 4 of IC1, which normally derived its signal from the line output transformer? Since the signal voltage levels at these two points were roughly compatible, it seemed to be worth a try.

It was simple enough to set up, and I used a 0.1μF capacitor as a coupling medium, just to avoid any likely DC conflicts. But this time there was no joy. The CRO confirmed that the pulse was being maintained right up to pin 4 of IC1, ie, no shorts, but there was nothing coming out of pin 1 to drive TR3.

At this point I decided that I had better have a closer look at this part of the circuit. There are two other transistors in the power supply, TR2 (2SC2022) and TR4 (2SC1685) and I had tended to dismiss them on the assumption that they were some form of over-voltage or over-current protection circuit.

Closer examination showed that they were no such thing; along with a zener diode, D2, they formed a voltage regulator circuit for the 8.8V supply rail, the primary purpose of which was to supply pin 3 of IC1. Checking this rail with a meter confirmed my suspicion; there was only about 1V on pin 3.

Well, at least we were getting close. But was the voltage down as a result of a fault in the regulator circuit, or was the IC at fault with, say, an internal short. Having pulled the battery trick successfully with IC401, it seemed the natural thing to try it again with IC1.

I restored the connections to pin 8 of IC401, disconnected the 8.8V rail from the voltage regulator network (at D1) and connected the 9V battery in its place. A check with the meter confirmed that the battery was able to maintain its voltage on this rail, which seemed to rule out an IC fault so, with fingers crossed, I switched on.

And it worked. I had taken the precaution of connecting a meter across the 115V rail, just in case anything silly happened, but this came up spot on 115V, the picture tube warmed up, and we had a first class picture. So that seemed to put the fault squarely back in the voltage regulator network.

Apart from the two transistors there are only a few other components involved, but I decided to check the transistors first. I pulled each one out in turn and checked it, but both proved to be intact, at least as far as I could check them. And, while I was prepared to replace them if necessary, I had a feeling that they were not at fault.

I checked the zener diode, D2, and the rectifier diode, D1, but these also seemed to be OK. That left about four resistors, so the actual denouement was something of an anti-climax. The culprit proved to be R2 and, to a lesser extent, its companion R34, both 100kΩ in the base circuit of TR2. R2 read no less than 5.5MΩ while R34, although a lot better, was still higher than it should have been. I replaced both and away went the set like a bought one.

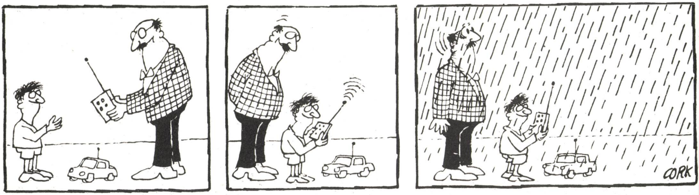
Afterthoughts

But there are a couple of afterthoughts about this story. One concerns the use of a battery as an alternative power supply for the two ICs. Would not the regulated power supply have been better? For a couple of reasons I suggest not. One advantage of the battery is that its internal resistance is naturally quite high and, in the event of a major fault, it is not likely to cause any serious damage.

The other advantage is that it is a floating supply; an important one when working with modern transformerless, hot chassis systems. While this does not rule out a mains operated power supply, if it was all that was available, the battery makes things a whole lot easier.

The other afterthought is about those two resistors. I suspect that they were being overrated in both the power and voltage sense, plus the fact that they were both pretty tatty looking devices, not in keeping with the rest of the components. On the other hand I was able to confirm, both from observation and the set's history, that they were original components.

They were of half watt rating but were connected virtually directly across the 320V supply from the bridge. According to my calculations this means that each would dissipate a fraction over half a watt; which is cutting things pretty fine even in the most favourable circumstances. But it must be



remembered that resistor wattage ratings are based on free air operation and that, in practice, this figure needs to be at least halved.

Then there is the voltage factor. Each would have 160V across it, and this could well have been excessive for resistors of this size and quality. Anyway, I fitted a pair of 1W hi-stab types and I don't imagine we will have any more trouble from that source.

But, if you're handling one of these sets it might be a good idea to check those two resistors as a matter of routine.

A tricky Ford Laser

Just lately, I seem to have run into a rash of car troubles. First the water pump on my ageing Holden packed it in, followed in quick succession by the headlight dipper switch, the heater, the boot lock and the vacuum modulator valve in the automatic transmission.

It was the last problem that was the most worrying — at least, until I discovered the cause. The transmission doesn't want to change up from second and the exhaust smokes like a backyard barbecue on a rainy day. Fortunately, the cure isn't expensive.

Then there was Mrs Serviceman's Ford Laser. It threw a tantrum and began blowing a 15A fuse in one of the main lighting circuits. This fuse controlled the parking lights, dash panel lights, number plate lamp and tail lamps, so its function is quite critical.

The real puzzle was that the fault was intermittent. The car would behave normally for a couple of weeks and then, for no apparent reason, the fuse would blow. At the end of a three month period, spent fuses littered the bottom of the glove compartment like dead soldiers on a battlefield.

These failures came as something of a shock to Mrs Serviceman. The Laser — a Ghia no less — is her pride and joy and, for the two years since new, had been completely reliable. Finally, after about the sixth fuse, she demanded that something be done. My smug reply that the car might have to be traded in didn't cut much ice and she was even less impressed when I assured her that the fault probably lay somewhere between the front of the car and the back.

My first approach was to see if I could isolate the fault by progressively turning on all the car's electrical equipment, but this was notable only for its lack of success. Everything functioned correctly and nothing I did would make the fuse blow. Back to the drawing board.

Next, I dismantled and carefully examined the number plate lamp and tail light assemblies. I checked the wiring and the connectors for possible shorts, but found nothing. I also checked out the front headlight assemblies and the wiring to them — again I could find nothing wrong.

Finally, for want of a better idea, I inverted myself in the cabin and, with the aid of a trouble lamp, peered as best I could behind the dash panel. The only result was a sore back which was not surprising considering some of the positions I got myself into. Your serviceman is getting much too old for this type of caper.

To cut a long story short, I crawled over every centimetre of that Laser and got nowhere. It just didn't seem to make sense. Something was shorting out fairly solidly somewhere, yet everything was in perfect working order. I decided to call it a day.

As is the nature of these things, the fault decided to lie doggo for the next couple of months. Then it was back again, only this time the fuse blowing was somewhat more frequent. It was time for a different approach.

Bump sensitive

Since the fault first appeared when the car was on a dirt road, I reasoned that it was probably "bump sensitive". Perhaps I could simulate the fault condition by rocking the car back and forth, or by bumping the light assemblies and the dash panel with the palm of my hand. It was worth a try.

Rocking the car back and forth proved fruitless so I began my bump tests, beginning with the headlight assemblies, then graduating to the dash panel, and finally moving to the tail lights. Nothing happened until, almost as an afterthought, I gave the bumper bar a thump immediately above the number plate lamp. There was the unmistakeable crackle of a short circuit and the fuse blew.

Gotcha!

Well, not quite, I still had to find the cause and this required a closer look at the number plate lamp assembly. It didn't take long to establish that the lamp is housed in a metal-bodied holder which, together with the number plate, is bolted to a metal bracket. This arrangement, in turn, is bolted to the bumper bar, the latter made from polycarbonate material.

COMPUBEASTS
WHO'S IN CHARGE HERE?
NOW THAT'S A GOOD QUESTION MADAM.

Because the bumper electrically isolates the bracket from the chassis, a separate earth lead is run to the lamp holder along with the usual +12V lead. Both these leads pass through automotive-style quick connectors. The only point of note in this instance was that the wiring colour codes across the connectors did not match up.

Dropped penny

Suddenly the penny dropped: the leads to the lamp holder had been transposed. It didn't take long to confirm my suspicions. I hooked a voltmeter between the bracket assembly and the car chassis, replaced the spent fuse, and switched the parking lights on. The meter read 12V — the bracket, the number plate, and the lamp holder were live!

So why was the fuse blowing? Simple. The bumper bar was flexible enough to allow the metal bracket to just make contact with the car body. So, whenever the car hit a decent bump and the lights were on, the fuse blew.

The cure was equally simple. I transposed the leads at the quick connectors and, *voila* — the number plate stopped giving forth with the volts. Now why couldn't Ford have made the car like that in the first place?

The answer to this question is that it was all too easy for someone to transpose the connections on the assembly line. And why not? As far as the assembly worker is concerned, the two connectors are exactly the same and the lamp will work no matter which way round they are connected.

Finally, why did this fault, which had been in Mrs Serviceman's car since new, take so long to show up? Again the reason is not too hard to find. A couple of months before the fault first appeared, the car was hit from behind by a motorcyclist who allowed his machine to roll forward at the traffic lights. There were no visible signs of damage but, apparently, it shifted the bumper just enough to bring the metal bracket within range of the body.

If not for this rear end shunt, the fault would probably have never been discovered. In fact, I'd be fascinated to know just how many Ford Lasers are running around out there with live number plates. I'd be even more fascinated to learn whether Ford has recognised the problem and taken steps to prevent it.

Build this CRO from a kit

One of the most useful pieces of test equipment is an oscilloscope. Here we describe a simple, low-cost CRO suitable for home construction. It may not have some of the features of expensive models, but its price puts it well within the reach of the average home constructor.

by ANDREW LEVIDO

An oscilloscope is perhaps the most useful piece of test equipment after a multimeter. If you have ever built a project and found that it did not work, even after you had checked all the components and voltages, then you have probably wished you had a CRO. the problem, up till now, has been the cost of these instruments.

This CRO however, with a price tag of $229, is well within the reach of most hobbyists. In fact, it is less than the cost of some digital multimeters.

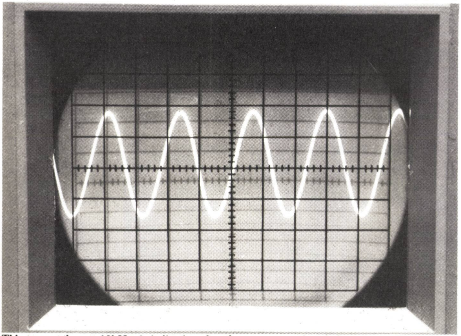
For a long time now, it has not been an economical proposition for a CRO to be built at home. Manufacturers have been able to put CROs on the market for less than the cost of an equivalent home built model. This situation has changed now with this Good Will CRO kit being marketed by Jaycar. The kit comes complete with everything necessary to put together a professional-looking instrument, and it can be assembled in a short time with very little difficulty.

The assembled oscilloscope is a compact unit with a 75mm screen. It has a single trace with a free-running sweep generator and an uncalibrated vertical amplifier. The well finished case comes with a pale brown steel cover and a professionally produced front panel.

All operator controls are neatly set out on the front panel except for the focus and intensity controls which are on the rear of the case. Overall dimensions are 200 x 300 x 150mm (W x D x H).

The vertical amplifier features a 5MHz bandwidth, which is more than adequate for audio and many digital applications. Sensitivity of the prototype was 22mV per division but the oscilloscope is capable of displaying waveforms down to 5mV p-p satisfactorily. The input impedance is greater than 750kΩ on all attenuator settings and input voltages can be as high as ±50VDC or 70V RMS. The horizontal amplifier has a sensitivity of 250mV per division and a bandwidth of 500kHz.

Although the specifications are fairly modest by today's standards, this CRO represents an attractively priced alternative to the expensive and often complex laboratory-standard units. We believe that this CRO will be popular with the hobbyist who cannot justify spending the sort of money usually asked for 10 to 20MHz dual-trace CROs.


This trace, taken at 10kHz, is indicative of performance over the whole range.

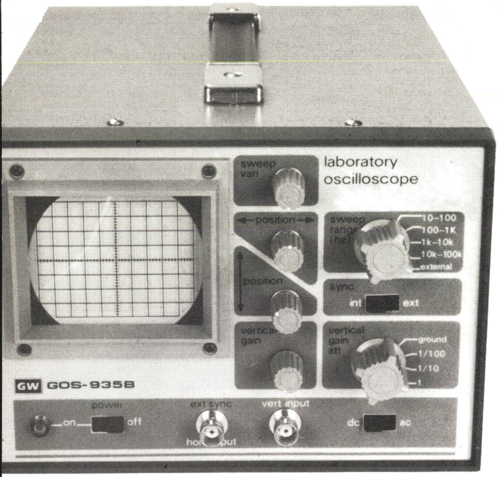
Input to the CRO is via BNC connectors which means that any of the readily available standard CRO probes can be used. There are two of these connectors on the front panel, one for the vertical input and one for an external synchronisation signal or the horizontal input when the CRO is in the XY mode. There is also a slide switch on the front panel to select DC or AC-coupling to the vertical input stages.

Front panel controls include a 4-position vertical gain attenuator with 3 values of input attenuation and a ground position. Next to this is a continuously variable vertical gain pot. There are the usual horizontal and vertical position controls as well. The horizontal timebase is selected by a 5-position rotary switch with four ranges covering 10Hz to 100kHz as well as an external timebase position.

Synchronisation of the display is by means of a free running sweep generator and so a variable sweep control is included to allow the displayed waveform to be stabilized. A slide switch is included to select either internal or external synchronisation. A mains switch and a LED indicator complete the range of user controls.

How it works

The operation of the oscilloscope is most easily understood by referring to the block diagram. The circuit has been broken down into seven main parts. These are: input attenuator; vertical amplifier; cathode ray tube; sweep generator, horizontal amplifier; blanking circuit and power supply. Each of these sections will be considered in turn and



the operation of each part briefly discussed in conjunction with the circuit diagram.

Input attenuator

The signal to be displayed is brought into the input attenuator via the DC-AC switch which allows DC or AC-coupling to be selected. In the DC position the signal is connected directly to the input attenuator but in the AC position the signal is coupled into the attenuator via a series capacitor. This capacitor blocks any DC component which may be present on the input signal.

Three levels of attenuation are provided, as well as the option of grounding the input of the vertical amplifier. Attenuation is provided by resistive dividers on the 1/10 and 1/100 ranges, the signal being coupled straight into the vertical amplifier on the 1/1 range. High frequency compensation of the dividers is provided by the associated variable and fixed capacitors.

The vertical amplifier circuit converts the low-level input signal into high-voltage signals required to drive the deflection plates of the CRT. The gain of this amplifier is continuously variable over a small range by means of the vertical gain pot (R114). This allows the user to vary the height of the waveform displayed on the screen. The DC offset of this amplifier can also be varied by R124, the vertical position pot. This allows the vertical position of the trace to be adjusted.

The deflection plates require a high voltage complementary signal, which must be supplied by the vertical amplifier. A phase splitter, Q101, is used to derive these signals which are then amplified by the following circuitry. This amplifier is DC coupled throughout since it must have a response down to DC. Feedback is applied around each side of the output stage by R135 and R136.

The CRT itself consists of an electron gun which produces a stream of electrons travelling in the direction of the screen. This is followed by an electrostatic focussing and accelerating assembly which focusses the beam into a narrow intense spot on the phosphor at the end of the tube.

Sweep generator

There are two sets of deflection plates in the tube, set at 90 degrees to each other. These plates electrostatically bend the beam in the horizontal and vertical directions, depending on the magnitude and polarity of the voltages applied between opposite plates.

In order to make the electron beam sweep across the screen from left to right a ramp voltage must be applied to the horizontal deflection plates of the CRT. The beam must then return to the left hand side of the screen. This return trace, or retrace, should be much faster than the original left to right movement of the beam.

The sweep generator provides the sawtooth waveform necessary to do this. The frequency of this sawtooth, and hence the speed of the beam across the screen is determined by the setting of the sweep range switch and the sweep vary R207 control.

The ramps are generated by a constant current source (Q203 and its associated components) which charges a capacitor (C203 to C205). The capacitor is selected by the sweep range switch. The sweep vary pot controls the amount of current delivered by the source.

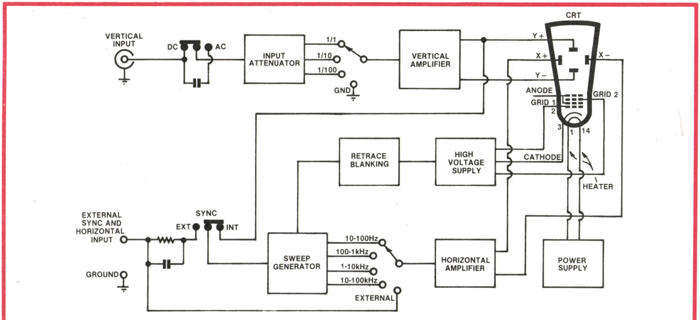
When the voltage across the selected capacitor reaches a critical value, the capacitor is discharged via Q202, Q201, and R226. This whole process repeats, generating the required sawtooth waveform, which then passes into the horizontal amplifier.

The horizontal amplifier provides signals of a suitable level to drive the deflection plates of the CRT. The input to this amplifier is selected by the sweep range switch, which has a position to allow an external signal to be applied to this amplifier. This permits the CRO to be used in the X-Y mode.

The horizontal deflection plates, like the vertical deflection plates, require complimentary drive voltages. These are supplied by the differential pair Q205 and Q206. The input signal is applied to one input, and a DC voltage from the horizontal position pot is applied to the other. The resulting outputs, taken from the collectors of the transistors, are the required drive voltages.

If the electron beam was visible on the screen during the retrace period it would make the display very confusing. In order to avoid this problem the beam is turned off during this time. This is the job of the blanking circuit. This circuit senses the falling edge of the sawtooth waveform and cuts off the electron beam when this occurs.

It is necessary that there be some kind of synchronisation between the waveform to be displayed on the screen and each of the ramps applied to the horizontal deflection plates if a stable display is to be achieved. There are several possible ways to accomplish this synchronisation, and the designers of



This block diagram, in conjunction with the circuit diagram, will help explain the various functions.

Build this CRO from a kit

this instrument have chosen one of the simplest and cheapest.

If the internal-external switch is in the internal position, the waveform applied to one of the deflection plates is sampled, and this sample is used to ensure that each ramp begins at the same point on the input waveform. With the switch in the other position an external signal can be used for synchronisation.

The result of this is that it is necessary to adjust the frequency of the sweep generator to achieve a stable display. The sweep control (R207) is provided for this reason. The main disadvantage of this method of synchronisation is that it is not possible to take frequency measurements directly from the display.

The last block left to describe is the power supply which provides the voltage rails required by the circuitry and the CRT. This CRO uses a fairly conventional power supply arrangement with a multi-tapped transformer providing the various voltages to the power supply circuitry.

The CRT requires 6.3VAC for the heater as well as an acceleration voltage of −1200V. This high voltage is derived by a voltage doubling rectifier from the 500V tap on the transformer. This rectifier consists of diodes CR306, CR307, CR311, CR312 and the associated capacitors and resistors. Two diodes are used in series to obtain a high peak inverse voltage rating.

The other supply rails are provided by full wave rectifiers and filter capacitors from the other taps on the transformer. The ±9V rails are regulated by zener diodes CR309 and CR308. The 150V rail is derived from the 170V rail via the dropping resistors R302 and R303.

Specifications

Screen size	75mm
Sensitivity	22mV per division
Bandwidth	5MHz
Input impedance	750kΩ minimum
Maximum input voltage	±50VDC or 70V RMS
Horizontal sensitivity	250mV per division
Horizontal bandwidth	500kHz
Input attenuator	3-position uncalibrated

Construction

Although this CRO is sold as a kit there is not really very much involved in putting it together. The printed circuit board is supplied fully assembled so only the mechanical assembly and the wiring has to be completed. The kit comes with a manual which contains the assembly instructions, adjustment procedure, parts list, circuit diagram and an explanation of the circuit.

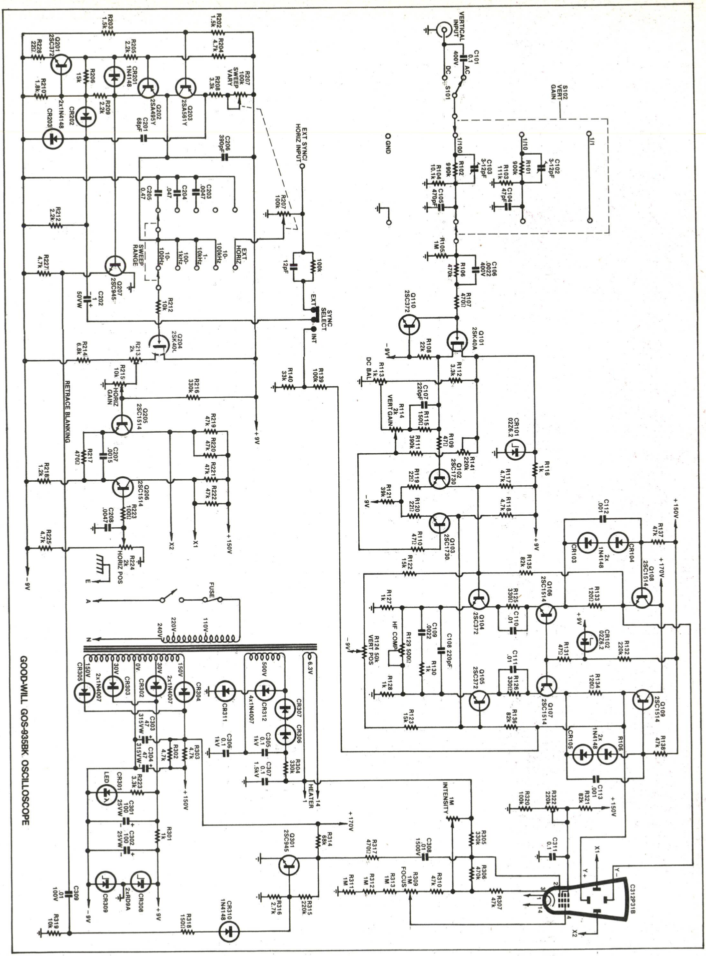
Only a few tools are required for construction, these being a few screwdrivers, a pair of pliers and a medium duty soldering iron. However, the setting-up procedure requires that you have access to a signal generator and a multimeter.

The manual itself is a little difficult to understand because it is written in the rather stilted English often found in publications originating in South-East Asia. Even so, we found it adequate for the assembly and setting-up of our unit. A few problems were encountered along the way but none that could not be solved by careful reference to the circuit diagram and a little common sense.

The preassembled circuit board seemed to be of reasonable quality and the only problem we found with it was that the 220V link had been soldered in instead of the 240V link. It was a simple matter to rectify this. Make sure you check this on your board before completing assembly.

The small circuit board which holds the CRT socket in our kit was a different shape to the one shown in the manual. This made it difficult to tell which wires went where, but reference to the circuit diagram and the pin numbers on the CRT socket enabled us to determine the correct connections.

As far as the mechanical side of the assembly went we had a few more problems. We were supplied with the wrong sized pot nuts and the wrong sized nuts for the BNC connectors. Four mounting holes for the slide switches had to be drilled in the front panel chassis because this had not been done at the



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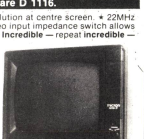

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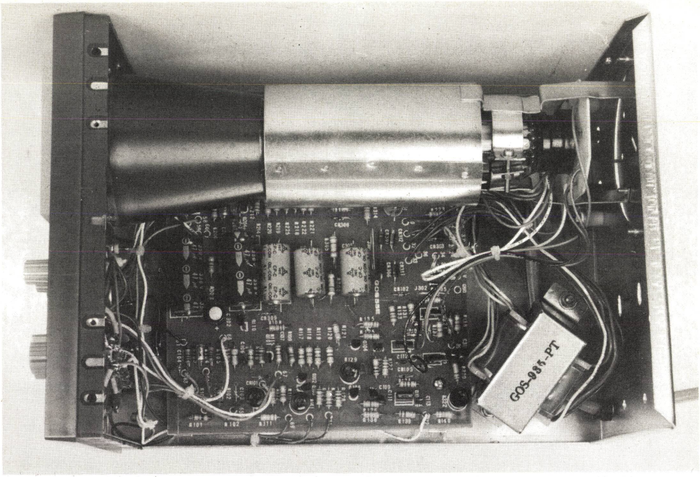

View inside the completed oscilloscope. The assembly is quite straightforward.

Build this CRO from a kit

factory. Apart from these problems the CRO went together well and the result was a nicely finished unit.

By far the longest and most difficult job is the wiring. All wires are provided cut to length with the ends stripped. Try to keep the wiring as neat as possible. When it is finished tie up the wires neatly with the cable ties provided. We found three problems with the wiring, all caused by errors in the manual.

First, the manual shows the CRO with three binding posts instead of the two BNC sockets provided. It is an easy matter to wire these in, the only difference being that instead of having a central ground terminal there are two solder lugs on the BNC connectors to be grounded. Secondly, we found no indication as to which way round the LED should be wired, but this can be determined from the circuit.

The third problem was a more serious one. There is an error in the wiring diagram on page 13 of the manual concerning the wiring to the vertical position pot. The brown and the purple wires, going to points 71 and 60 on the board are shown transposed. The circuit diagram is correct. Be sure to connect these the right way on your CRO otherwise the vertical position pot will not do what it is supposed to.

We had no real problems following the setting-up procedure. Each step is clearly set out in the manual, starting with static tests before switch-on and going right through all the functions of the CRO. This has the advantage of familiarising the user with the CRO's features.

The only problem we encountered during this phase of construction was in section 14 of the procedure. The manual refers to a trimmer capacitor C120 which does not exist. Capacitor C102 is the one that should be adjusted.

We had no other problems in constructing our CRO and the finished instrument was able to meet or exceed all of the manufacturer's specifications.

For further information, contact Jaycar Pty Ltd, PO Box 185, Concord 2137. Telephone (02) 745 3077.

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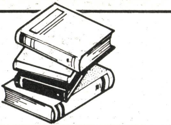
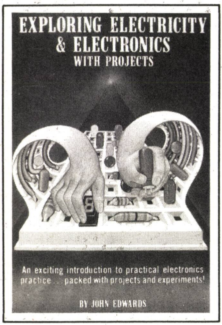
Books & Literature




EXPLORING ELECTRICITY & ELECTRONICS
WITH PROJECTS
An exciting introduction to practical electronics practice . . . packed with projects and experiments!
BY JOHN EDWARDS

Exploring electricity and electronics

EXPLORING ELECTRICITY & ELECTRONICS WITH PROJECTS: by John Edwards. Published by TAB Books Inc, 1983. Soft covers, 128mm x 209mm, 199 pages. Illustrated with line drawings, circuits and photographs. ISBN 0-8306-1497-4. Recommended Australian price, $17.95.

The aim of this book appears to be to provide a mini-course in radio and electronics, at least to the point where the reader can attempt simple constructional projects. I say "appears to be" because the introduction fails to define the aim clearly. The author appears to get sidetracked before he can get around to it; a failing which crops up elsewhere in the book.

The book starts off at a very elementary level — the nature of electricity, its sources such as batteries, generators, etc — and, at a modest level, does a reasonable job. It includes chapters on DC circuits, magnetism and induction, and includes some simple experiments involving batteries, coils, lamps, magnets, etc, to demonstrate various basic principles.

Unfortunately, from here on the author seems to get bogged down and sidetracked by a desire to touch on every aspect of the subject under discussion. This includes mention and illustrations of quite complex commercial versions of various devices, to the point where the important basic principles are skimped and overshadowed by commercial hardware.

In short, he says a little about everything, but nothing very substantial about anything.

Granted, there are a few simple construction projects, such as power supplies, battery chargers, audio oscillators, code oscillators, and diode (crystal) receivers, but they contain little or no information as to how they actually operate.

Particularly disquieting is the publisher's blurb on the back cover. "Save time and money . . . get the know-how needed to maintain and repair all those electronic gadgets, games and systems that have become a part of your everyday life — electronic games, TV sets, car ignitions, even computers!"

The truth is that no one needing to start at chapter one of this book would be qualified, by reading it, to undertake anything more than the most elementary repairs to any of the devices mentioned.

In short, not particularly recommended.

Our copy from Thomas Nelson Australia, 480 La Trobe St, Melbourne 3000. (P.G.W.)

Modern Thermoelectrics

MODERN THERMOELECTRICS: by D. M. Rowe and C. M. Bhandari. Published by Holt, Rinehart and Winston, London, 1983. Hard covers, 155mm×240mm, 157 pages, illustrated with line drawings, graphs, and photographs. ISBN 0-03-910433-8. Price in England, £9.50.

This is a specialised engineering textbook dealing with the direct conversion of heat into electricity by means of thermocouples and the complementary (Peltier) effect of direct refrigeration by passing current through a suitable couple.

While both effects have been known for over 150 years, it is only recently that they have been regarded as more than a scientific novelty, apart from a few simple metering applications. More recently a lot of research and practical work has been done towards producing practical power generators and refrigeration systems.

There appears to have been two major reasons for the upsurge of interest; the development of semiconductor materials offering much improved efficiency, and the demand for specialised power plants for use in remote and hostile environments, particularly in space exploration.

This is not a book for the casual reader, but should prove highly valuable to any engineer needing to expand his knowledge of this subject in the light of its increasing importance.

There are 10 chapters in all: Definitions and Basic Principles; Elementary Solid State Theory and Thermoelectric Transport Equations; Optimisation of the Thermoelectric Figure of Merit; Thermoelectric Materials; Thermocouple Construction and Configurations; Thermoelectric Refrigerators; Thermoelectric Generators; General applications; Conclusions; Appendix.

Extensive references are provided at the end of each chapter and these alone would prove invaluable to anyone needing to investigate this subject in depth.

In summary, a specialised text book for the thermo dynamics engineer and which, at the likely price on the Australian market, would appear to be very good value.

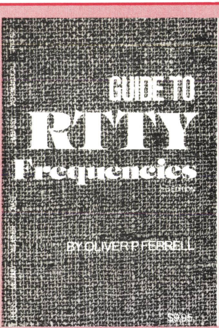
Guide to RTTY frequencies

GUIDE TO RTTY FREQUENCIE
by Oliver P. Ferrell. Published by Gilf
Associates, Inc, New Jersey, USA. So
covers, 193 pages, 153 x 229mm. ISB
0-914542-11-7. Recommended reta
price $14.95.

This book is aimed at th
RTTY enthusiast who likes to interce
commercial RTTY traffic. Apart fro
the first 16 pages, which are devoted
general RTTY background, the book
devoted to listing known commerci
RTTY stations.

The list is presented in two formats; b
frequency and by call sign. (Althoug
not easy to find unless one knows the ca
signs, some Australian stations we
found, in the "V" call signs). A very lar
number of stations are listed, part
because they are not restricted to new
services, but include marin
aeronautical, weather, and oth
services, and partly because they do n
appear to be restricted to Engli
language transmissions.

For those interested in suc



information, this book would seem to be the most comprehensive we have seen so far.

Our copy from Dick Smith Electronics, PO Box 321, North Ryde, NSW 2113. (P.G.W.)

Our copy came direct from the publishers, Holt, Rinehart and Winston Ltd, 1 St Anne's Rd, Eastbourne, East Sussex, England, BN21 3UN. (P.G.W.)

Developments in Teletext

IBA TECHNICAL REVIEW; DEVELOPMENTS IN TELETEXT: Edited by Paul Gardiner, BSc, IBA Engineering Service. Published by the Independent Broadcasting Authority (Great Britain), Crawley Court, Winchester, Hampshire, SO21 2QA. Soft covers, 68 pages, 194 x 227mm, illustrated with photographs and diagrams.

This is a collection of seven papers by various engineers, mostly from within the IBA, but some from associated industries, dealing mainly with Teletext at broadcast engineering level, involving various standards, and possible future developments. However, there is one paper from Mullard dealing with integrated circuits for receivers.

Most of the papers are quite deep technically and, being of a specialised nature, would appeal to only a limited audience. On the other hand, this audience would undoubtedly find it extremely valuable.

Our copy came direct from the publishers and is available free on request to IBA. (P.G.W.)

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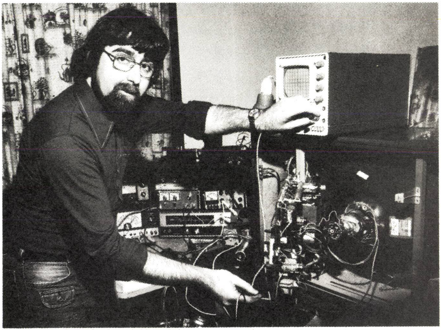

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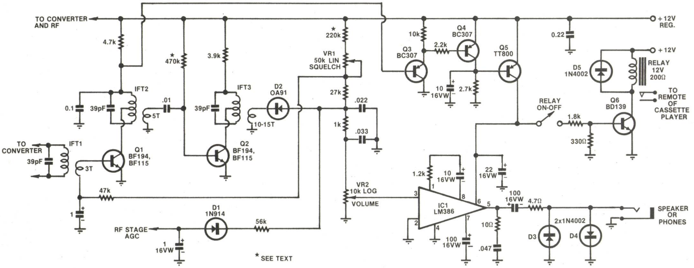
Circuit & Design Ideas

Interesting circuit ideas from readers and technical literature. While this material has been checked as far as possible for feasibility, the circuits have not been built and tested by us. As a consequence, we cannot accept responsibility, enter into correspondence or provide constructional details.



IF/audio circuit for VHF receiver

A very effective VHF receiver can be made using the front end of a cheap FM tuner modified to cover the 72 to 82MHz shortwave band. The RF, oscillator and converter coils are modified and the converted output coupled to the circuit shown. This comprises a three stage IF amplifier, detector and AGC, audio amplifier with squelch, and a relay to control a cassette recorder.

An alternative to modifying an FM front end is to build a suitable circuit from the ARRL or RSGB handbooks.

The IF stages operate at 1820kHz rather than the standard 455kHz. This higher frequency allows improved image rejection. The coils are made by rewinding standard miniature IF transformers such as DSE Cat L-0260. The primaries of each coil are wound with five layers of 38B&S enamelled wire, with the tapping at two layers. Windings for the secondaries are shown on the circuit diagram.

Gain of the audio stage using the LM386 is about 50, and the output can drive either headphones or a loudspeaker. Diodes D3 and D4 across the output of the amplifier clip the clicks which result from electrical interference.

The squelch circuit cuts the supply to the LM386 when the signal drops below a precetermined level as set by 50kΩ potentiometer (VR1). The overall triggering level can be adjusted by altering the 220kΩ resistor.

The squelch circuit can also be switched to drive the relay. This connects to the remote input of a cassette recorder so that it will begin recording when a signal level reaches that set by the squelch control.

Circuit layout must follow standard high frequency techniques. Keep all leads as short as possible and keep the high gain IF stages (Q1 and Q2) away from the audio amplifier.

J. Emery,
Bull Creek, WA.

$20

Light-sensitive switch

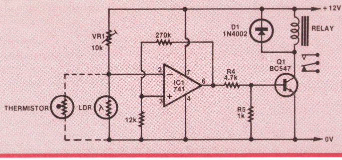
This switch could have a number of applications — it can be operated by either light or heat. Where an LDR is used as the sensing element, the relay will be operated by light which exceeds a predetermined level. Substituting a thermistor for the LDR will cause the circuit to trigger when a preset heat is exceeded.

The sense device (either the LDR or the thermistor) actually forms a voltage divider with the 10kΩ trimpot. The output of this divider varies in proportion to the amount of light or heat detected by the sensor.

The divider output is fed to the inverting input (pin 2) of IC1, a 741 op-amp wired as a comparator. When the sense voltage falls below a reference voltage on its non-inverting input (pin 3), the output (pin 6) goes high.

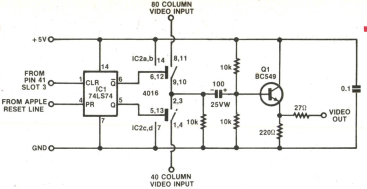
The output of IC1 drives transistor Q1 which, in turn, provides coil current for the relay. D1 protects the circuit against inductive kick-back from the relay coil.

The 10kΩ trimpot allows adjustment of the trigger point. Note that the thermistor should be of the NTC type.



J. Date,
Maharashtra, India

$12



Video switch for Apple computers

Many Apple computer owners have also purchased an 80-column video card and so have two video outputs from their computer. In order to change between 40-column and 80-column video, the user must unplug the monitor from one socket and plug it into another. This add-on circuit is designed to eliminate this fiddling about by automatically switching the video, according to the output format selected.

The device select pulse from slot 3 is connected to the clear input (pin 1) of IC1, while the reset line is connected to the preset input (pin 4). Thus when the 80-column board is selected (assuming it is in slot 3) the Q output of IC1 will go low and the $\overline{Q}$ output will go high. When the computer is reset, and falls back to the 40-column mode, the reverse will occur.

The Q and $\overline{Q}$ outputs of IC1 are connected to the gates of two CMOS analog switches (IC2) which control the video signal from the computer. In practice, two switches are used in parallel at each position since unused switches in IC2 cannot be left disconnected.

The selected video output is then buffered by emitter follower Q1. This allows the output to be connected to low impedance loads without serious attenuation taking place.

The prototype was built on a prototyping card and plugged into slot 5. The device select line from pin 41 of slot 3 was linked to pin 35 of slot 5 (an unused pin) by means of a length of wire under the board. Other relevant pin numbers for this slot are: 5 volts — pin 25, 0 volts — pin 26, reset — pin 31.

The only other connections required are the video inputs from the 80-column card and the main board, and the output to the monitor.

J. C. Holliday,
Nathan, Qld

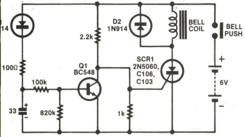
$15

Childproofing circuit for battery-operated doorbells

If you have a 'ding-dong' type of doorbell, you will know only too well that most children (and some adults) delight in pressing the switch repeatedly. This can be very annoying, particularly if you are not in a position to answer the door immediately.

This circuit overcomes that problem by allowing only one 'ding-dong'. A very simple timer resets only when the switch has not been pressed for several seconds. Installation is not difficult, and the circuit draws no current, except when the switch is pressed.

The prototype has been installed on a battery-operated 'Friedland' door-chime. Note that the circuit will not work on doorbells operated from a transformer, as it requires a reasonably smooth DC supply to work correctly.



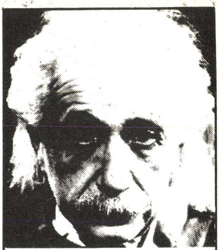
When the pushbutton is pressed, voltage is applied to the gate of the SCR via the voltage divider consisting of the 2.2kΩ and 1kΩ resistors. Initially, transistor Q1 is off and the SCR is triggered into conduction, energising the bell coil. Meanwhile the 33μF capacitor charges via D1 and the 100Ω resistor. When it reaches a critical level, Q1 turns on, grounding the gate of the SCR and preventing it from being retriggered.

When the pushbutton is released, the bell coil is de-energised and the SCR turns off. At the same time, the 33μF capacitor discharges through the base-emitter junction of Q1. If the pushbutton is pressed again before the capacitor is discharged, Q1 will still be on, and the SCR will not trigger.

The 820kΩ resistor is included to allow the capacitor to discharge fully while diode D2 prevents the back-emf generated by the bell coil from damaging the circuit. Diode D1 is included to prevent the capacitor discharging through the voltage divider.

G. Brunckhorst,
McDowall, Qld.

$15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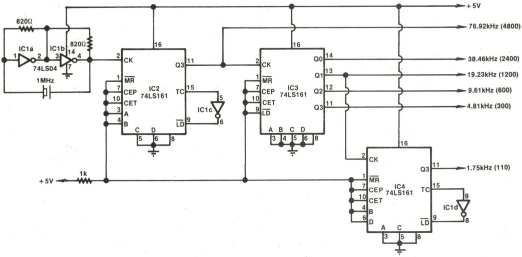
Circuit & Design Ideas

Simple baud rate generator



This simple baud rate generator can be used with most serial communication devices such as UARTs and ACIAs. It provides the necessary clock frequencies at 16 times the baud rate.

Six standard baud rates are catered for and these are 110, 300, 600, 1200, 2400, and 4800 baud. The 4800 and 110 baud signals, at 76.92kHz and 1.75kHz respectively, do not have 50% duty cycles, but this should not present problems with most serial devices.

A 1MHz crystal oscillator is formed by inverters IC1a and IC1b. This is divided by 13 with IC2 to derive the 4800 baud signal. IC3 further divides this frequency by 2, 4, 8 and 16 to provide the 2400, 1200, 600 and 300 baud rates respectively. IC4 divides the 1200 baud rate signal by 11 to derive the 110 baud signal.

The unit operates quite well in conjunction with the DATUM microprocessor trainer.

S. Sidoti,
Lilyfield, NSW.

$15

50Hz frequency indicator

The need for this unit was brought about by problems arising from the use of portable alternators run at the wrong speeds. This can cause difficulties when the load consists of induction motors or other frequency dependent devices. As the use of a frequency counter is hardly justified for this type of situation, this circuit was developed.

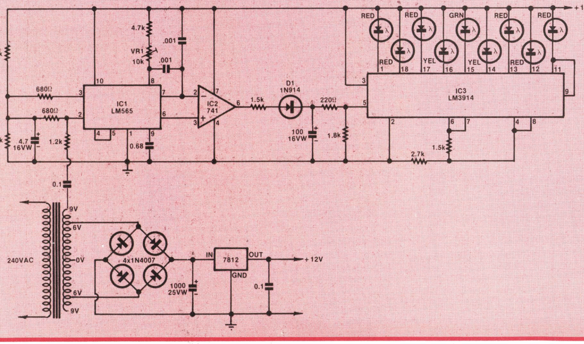
The unit is powered from the circuit to be checked, using a small multi-tapped transformer, bridge rectifier and 3-terminal regulator. The heart of the circuit is an LM565 phase locked loop (IC1) which compares a sample of the input frequency with an internal oscillator. An error voltage, which depends on the difference in frequency between the two oscillators, is amplified by a 741 op amp (IC2).

The output from the op amp is filtered and used to drive IC3, an LM3914 bar-graph driver. Only 9 of the available 10 outputs of the LM3914 are used, to maintain a symmetrical display consisting of a central green LED, with a yellow LED on either side, followed by 3 red LEDs on either side. With the component values shown, the resolution is within 2Hz per LED, a figure which enables the speed of the driving motor to set, with sufficient accuracy.

Calibration is easily carried out by using the mains as a reference, and adjusting VR1 to illuminate the green LED.

T.J. Whitlow,
Rangiora, New Zealand.

$18



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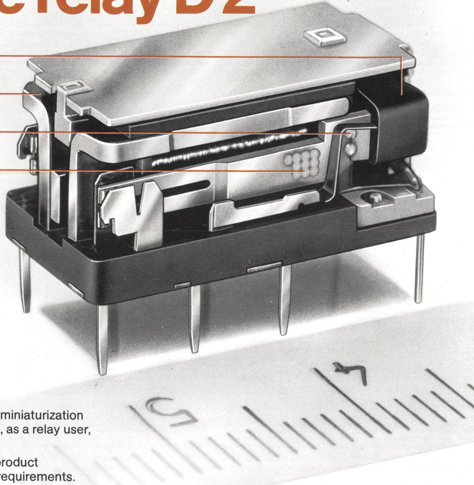
SIEMENS

Contacts you can rely on: Miniature relay D 2



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the contact blades

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reliability

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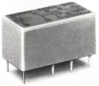
contact positioning

actual size
Miniature relay D2
(20.2 x 10.2 x 10 mm)



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The miniature relay D 2 can be used in a variety of applications such as measuring circuits, control-, regulating- and process systems, entertainment industry, telecommunications, signal systems and medical equipment.

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667/1170

Electromechanical components from Siemens

Circuit & Design Ideas

Quiz game adjudicator with digital scoring

Here's a gadget you can use to control quiz games like those seen on TV. It lights a lamp and sounds a buzzer to indicate which contestant pressed his button first and, in addition, displays the score for each contestant up to a maximum of 99.

The contestant's scores are displayed on 7-segment LED readouts and are incremented or decremented by the quiz master. Note, however, that negative scores are not possible.

Fig. 2 shows the quiz master's unit. This contains the power supply and an encoder (IC12a, b) for the three scoring pushbuttons: decrement, increment and clear. The decoder outputs, X1 and X2, connect to corresponding inputs on the contestant circuits. Note that the contestant circuit (Fig. 1) must be duplicated for each contestant, and the OK terminals connected together.

The contestant circuitry functions as follows. Two 4-bit counters, IC5 and IC6, together with 7-segment decoders IC7 and IC8, drive the LED displays. When a contestant presses the answer pushbutton (PB4), the flipflop comprising NAND gates IC2c and IC2d is set — ie, pin 10 low and pin 11 high. Q1 turns on to light the lamp and IC9 is triggered, sounding the buzzer for about 1 second.

At the same time, the OK line is pulled low via diode D1 and prevents other contestant answer pushbuttons from functioning.

The X1 and X2 inputs are decoded by IC1, pin 11 going high whenever either input goes high. Thus, there is a positive-going signal to pin 4 of IC3 whenever any of the three scoring pushbuttons (PB1-PB3) is pressed. IC3, a 4538 dual monostable, is connected to produce a 100ms pulse to allow time for the score counter to be clocked. At the end of this period, pin 7 triggers the second monostable in IC3 which produces a 33ms pulse from pin to clear the flipflop (IC2c,d).

Dual monostable IC4 also decodes the X1, X2 inputs and uses this information to drive the 4510 BCD counters (IC5 and IC6). Pin 10 of IC4 is connected to the up/down control pins of the 4510s, while pin 7 clocks the counters. Pin 3 monitors the output of IC2d and enables the count output only if pin 11 (IC2d) is high, ie, if the contestant's button has been pressed.

A separate regulator is used for each contestant circuit to ensure a constant display brightness. This regulator can be omitted for the second and further contestant circuits if heavy gauge wiring is used for the supply connections.

P. Stoddard,
Charmhaven, NSW. **$25**

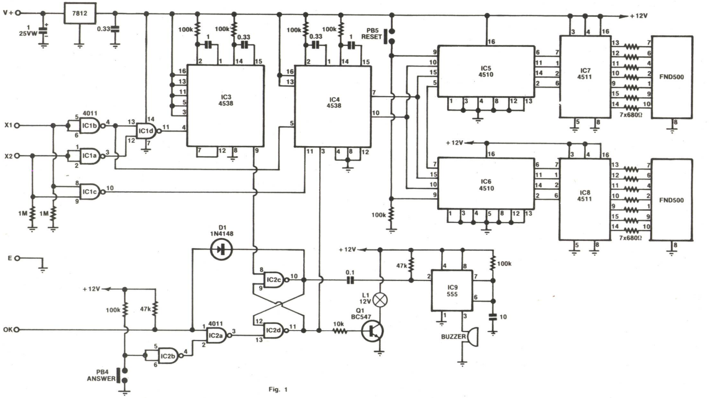


Fig. 1

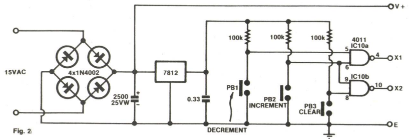


Fig. 2

Know-it-alls & do-it-alls

It was in the April issue that a young reader first complained about the difficulty of obtaining a job in the electronics industry. Here, in October, we're still carrying letters on the subject, indicating a continuing interest and widely differing points of view. This, plus a spirited attack on Editor Leo Simpson for his recent editorial on "engineers".

FORUM

Conducted by Neville Williams

First to hand is a letter (on company letterhead) from A.M. in Fyshwick, ACT. While professing a "thorough distaste" for airing his opinions in public, he says: "... your recent discussions on job prospects in the electronics industry are important enough not to ignore."

Then follows an expression of opinion generated, I would imagine, from experience on both sides of the job interview desk:

> *All your published contributors to this debate, so far, suffer from myopia caused by holding down a job, with very few different employers, for too long. If you want to know the reality, resign your present position once in a while, get out into the marketplace and try to sell your abilities.*
>
> *You would find a solid wall of apathy, ignorance and technical incompetence from receptionists through to managing directors.*
>
> *The best way for a job seeker to be successful is from persistent experience in the art of job seeking. One way involves phoning prospective employers obtained from the yellow pages and trade magazines.*
>
> *Alternatively or also, try the door-knock approach armed with a glowing resume and your wits. If possible, get the name of the man who hires and fires, first, or you will not get past the receptionist. Until you are speaking to THE man, avoid stating your purpose to inconsequential people.*

Reading the above, one would gather that A.M. disapproves of correspondents who, having worked long years in a very few jobs, take it upon themselves to advise present-day job seekers. Maybe they should resign from their present position and re-discover what job hunting is really like in the here and now!

He would also appear to have a chip on his shoulder in respect to managing directors and their "inconsequential" minions — characterised by "apathy, ignorance and technical incompetence". Presumably he sees them as being collectively insensitive to the needs and skills of job applicants.

So don't play the jobs game their way; somehow or other, get through to the actual decision maker and sell yourself!

That's fair enough advice for the seasoned campaigner, A.M., but I doubt its relevance to a young person who is still at the bottom of the employment ladder — particularly if he/she is hoping for a position in a large company or public instrumentality.

The letter continues:

> *Any employer worth working for is looking for competence first, followed by the three Rs and an appropriate appearance, in that order. These qualities are not interdependent.*
>
> *The only real way for an employer to judge competence is by trial and error on the job, with a probation period. Over-reliance on trade certificates and previous experience is preventing many good people from finding their proper niche in life. The results are misfits with sour hearts, false smiles and shoddy workmanship.*

I would certainly not argue with the idea that competence is vitally important, although I must insist that there are some positions where the other qualities are an integral part of it.

The point is, however, that job applicants rarely come complete with an ironclad guarantee of competence and the prospective employer has to form a judgment based on factors ranging all the way from formal training, through previous experience, to his own gut feeling.

A.M. virtually admits as much when he suggests that the only real way to judge competence is during a probationary period on the job.

While a probationary period has much to commend it, my own experience has been that it is not always a very practical arrangement. Frequently, the most promising applicant is a person who already has a permanent position but who is looking for greater opportunities. They may not be prepared to commit themselves to a situation where a new employer can, too lightly, dismiss them at the end of three months.

Nor have I, as the interviewer, relished the idea of exposing someone with an existing job and responsibilities to the risk of unemployment, unless I was pretty certain that the risk was minimal.

A.M. continues:

> *The present chronic lack of people in this industry, so glaringly apparent, and typified by the virtual death of the local manufacturing industry, is the result of deplorable employment procedures, over the years, by well spoken, presentable people that could not check a diode with a multimeter and, more important, an education system with its emphasis on social and "arty" subjects rather than hands-on, everyday practical experience.*

Whoa! Hold hard there, A.M. While I deplore as much as anyone the fate our local electronics manufacturing industry, I certainly won't buy that last argument. Basically, demise of the industry was the outcome of deliberate, major economic restructuring by the Federal Government.

By world standards, the Australian electronics industry was a modest operation, with limited output and resources, operating behind a protective tariff barrier. When the need arose to import more manufactured goods to offset our sales of raw materials, the electronics industry was one of those selected for the chop. Down came the tariff barriers and in came a flood of components and equipment, better and cheaper than our own, by reason of large-scale research, automation and cheap labour.

What A.M. describes as "the present chronic lack of competent people in this industry" is not the cause of that debacle, but the end result of it!

Nowadays, with few electronics factories and few production lines, the

an engineer has his say

on-going supply of technical recruits has been interrupted; I refer to the one-time progression from process-workers to inspectors, to testers, to troubleshooters, to technicians/servicemen/hobbyists, with a proportion of them taking up formal training.

I despair that even "practical" courses can effectively substitute for wide-ranging day-to-day industry involvement and interchange.

If it were not for this typewriter, my own i's would not be crossed nor my t's dotted — but the substance of this letter would not be changed one iota. By knocking competent illiterates, it may be forgotten that many of them grow our food, service our machines, write books (eg, O. Henry — "The Verger") and some become statesmen. The other kind push paper, and that helps explain the regulatory mess which all productive people must contend with.

My sympathy and best wishes to all who really want a job in the electronics industry.

A.M. (Fyshwick, ACT)

As I read that final paragraph, two things struck me rather forcibly. First off, while A.M. champions the cause of "illiterates" and even hints that he is one himself, his letter shows none of the spelling or grammatical errors that we originally talked about. Perhaps, while other correspondents are experimenting with unemployment, A.M. should be looking at typical, present-day high-school essays, to up-date himself in that area!

The other point is his Rolf Harris-like facility with the broad (verbal) brush.

I'm not aware that I, or anyone else, has been attacking illiterates. What I did do in the April issue (page 29, col 1) was to point up the changing face of electronics from the "static" and comprehensible hardware of the '40s to today's "enormously complicated" and enigmatic solid-state circuitry. In that context, my strong advice was to back up hobby activities with formal training and also to suggest that, in today's highly competitive job market, it is an advantage to be tidy and well spoken rather than the reverse.

I'll stand by that opinion.

Another letter on the same general subject comes from S.G., whose address I appear to have mislaid. It opens with general comment on the original correspondent (April issue, the young man from Eagleby) and his generation, and their frustration at being rejected for the wrong reasons by members of "our" generation: "with a Leaving Certificate and a mediocre E&C pass, we might turn Eagleby down for a job, on account of he don't talk real good English, like!"

From there he goes on:

The obsession with qualifications, it seems to me, is an employer admitting he doesn't know how to assess a job candidate's suitability. Beyond proof that the candidate must possess application sufficient to endure the boredom of a formal education, in order to obtain a qualification that the Boss doesn't understand, what does it prove?

You state, Neville, that "certainly for this magazine" a formal qualification is necessary but do you print 'The Serviceman' for his technical proficiency and qualifications, or his engaging colloquial style? Which of these is the greater? Would you print a boring column on the same subject by a BSc? Or by a popular columnist, if she possessed nothing more than . . . etc.

"The obsession with qualifications": the phrase reeks with a hard-line us-and-them philosophy; as if qualifications or experience were mutually exclusive alternatives.

How about a combination of the two?

How about re-reading what I actually said in the April issue (page 29 col 1) when offering advice to young people contemplating a technical career in electronics in year 1984. As distinct from an isolated phrase, the whole paragraph read thus:

"Nowadays, for the industry as a whole, and certainly for this magazine, a certificate or degree, or formal training towards that end, is almost a prerequisite for a career in electronics. A parallel hobby interest is valuable in imparting practical depth to the theory but a hobby interest alone is a very tenuous basis for technical advancement."

Why so?

Because a hobbyist or doer/learner tends to assemble information in a spasmodic way, often producing an end result without necessarily understanding why. Weird and wonderful is some of the "theory" bandied about by those who have no stomach for book learning!

Like it or not, as distinct from merely enduring the "boredom of a formal education" a good student stands to gain a basic, structured understanding of the subject, with the ability to enlarge upon it in an orderly way.

But the matter doesn't end there. Let me add another quote from the April issue:

As a hobbyist from way back, I must confess to reservations about the commitment of anyone who can spend years studying a subject like electronics, without ever generating an unstoppable urge to follow up some of those ideas at a practical level.

That quote, incidentally, is also relevant to what follows a little later.

Frankly, I doubt that many prospective employers would deny the difficulty of assessing the suitability of an applicant for a particular job but, as part of the process, it is logical to consider formal qualifications, or lack of them. It is also logical to consider work experience, or the lack of it, along with other relevant factors.

As for "The Serviceman", we publish his material because of his technical knowledge **and** his writing style. The combination of the **two** skills makes him a proficient technical writer . . . a point that will hopefully not be lost on A.M. above. In the event of his (The Serviceman's) demise, boring bachelors and clueless columnists need not apply!

Why did I bother?

I had just reached this point in the article, when a member of the EA staff called by to drop in a copy of the August issue carrying Leo Simpson's editorial entitled: "So you think you're an engineer, mate". With it was a letter, reproduced in the accompanying panel, from a very disgruntled engineer.

Having read both items, my immediate reaction was to tear up what I had written, sell my typewriter and take up bird watching instead!

I had been recommending formal training, but here was Leo proclaiming his disillusionment with formally trained job applicants. Perhaps I should say: even with formally trained job applicants.

And, on the other side, was a qualified engineer putting Leo down in terms so completely theory-orientated that champions of the "practical" approach would be more than ever convinced about the validity of their ideas.

Oddly, perhaps, I was reminded of a Sydney electronic components manufacturer who was successful enough in the market place to support an enduring and comfortable lifestyle. It was all based on practical know-how, he

FORUM — *continued*

explained one day; he had never felt the necessity to employ a "ginger beer"!

Anyway, best you read the letter now, if you haven't already done so.

Before commenting further, I should perhaps emphasise that the questions raised by Leo Simpson and Greg Swain during job interviews were not in the context of a structured verbal examination. They were intended, rather, to guide the conversation into a variety of technical areas likely to be encountered in the actual job situation. How conversant were the individual applicants with the practice and principles of this, that and the other? How wide ranging was their interest? How deep their motivation?

Leo and Greg's concern sprang from the fact that while some of the applicants could discuss practical electronic equipment with varying degrees of facility, others appeared to be quite unconcerned and uninvolved in the electronics of the real world.

Undoubtedly, the interviewers' expectations, like mine in the past, reflected the basis on which a technical magazine is produced: by, and for, people who have a spontaneous and on-going interest in equipment of all kinds; people who can't look at a VCR, or a compact disc player, or a digital readout, or a modern pushbutton tuner without wanting to read about and understand something of its internal technology.

Normally, that involves routine reference to technical papers and magazines because, however good textbooks may be in terms of fundamental theory, they are usually well behind the latest increments and applications of that theory. Surely that is why we count among our readers, hobbyists, students and technicians, right through to engineers, scientists and academics.

From where we stand, the urge to

Please: don't confuse engineers with technicians!

I have just read Leo Simpson's editorial in your August issue and I am flabbergasted that he thinks himself qualified to dictate the curriculum of an engineering degree course. It sounds rather as if he has confused engineers with technicians.

I know the difference, because I have been both.

I would not expect an engineer to be familiar with radio telephony unless he was a broadcast engineer, or similar. I would equally not expect every journalist to be familiar with the finer details of photolithography.

I would expect an engineer to have an understanding of communications theory, without having his thinking channelled into one specific application of that theory. By using a knowledge of statistics, spectra, noise and filtering, he would eventually solve problems for which a superhet would not be the answer. You surely don't think that the superhet is the answer to all the world's receiver problems, do you? How would you provide a better receiver?

Rather than asking for a circuit of a complementary symmetry amplifier, you could try either: (1) giving him a circuit and asking whether it is stable, or (2) asking him to design an amplifier to create a certain output for a certain input — but don't expect him to do it on the spot.

Phase lock loops are a practical example of a well known fundamental concept — feedback theory. During my degree course, phase lock loops were never mentioned but we did study control systems in great detail. I'm sure any graduate could rapidly identify the type of feedback system employed in a PLL and easily calculate the steady state error, transient response and so forth, providing you posed the question in the Laplace domain. Converting a circuit diagram into the Laplace equivalent is a problem I would not consider suitable for a verbal interview.

Alternatively, given the desired response of the PLL, a reasonably competent engineer could rapidly design a phase lead or lag circuit to match the PLL to the desired requirements.

A three-gate oscillator? I am familiar with many oscillators, from Hartley to Colpitts, from Wein bridge to twin-T, and have even made 7404s oscillate — not always deliberately. I haven't a clue what a three-gate oscillator is. If you mean a pair of 7404s with crystal and feedback resistors, I feel bound to point out that such a circuit was not really meant to oscillate in the first place and can be difficult to start, especially if the Vcc rises slowly. Just knowing the diagram for such a circuit is no substitute for being able to design something that will start every time.

As an aside, I think it unlikely that I will ever use a Wein or twin-T oscillator again. I get better results with counters and ADCs.

An engineer is someone who is called upon to apply fundamental theory to a problem that has never been solved before. A technician is someone who can be called upon to design a superregenerative receiver.

If an engineer knew all about vacuum tubes, he wouldn't be of much use today. Leave the power mosfets to the technicians. If an engineer needs knowledge about power mosfets or GaAs lasers, he knows where to get it. I don't think every engineer should commit it to memory. When he does require that information, he gets it in greater detail than is presented in the pages of EA.

I have bought every issue of EA since 1960 but I doubt that I will buy any more. They are not on the circulation list at my place of employment; they lie around the coffee room as light entertainment. I no longer think you retain any credibility if you insist that VCRs, superhets and mosfets are the fundamentals of engineering.

I personally regard the fundamentals of engineering as control system theory, feedback and stability theory, electromagnetic theory, communication theory and, in particular, the Laplace and Fourier transforms.

All these are wonderfully applicable to electric machines, valves, telegraph lines, transistors, GaAs lasers, VCRs, digital computers and even the human brain.

I could have told you long ago that a recent graduate was unlikely to be the sort of person you would want working for you. I feel let down that you did not know this.

Those interested in electronics seldom graduate. There is a distinct correlation between membership of the radio and electronics "club" and failing exams.

K. L. (Box Hill, Vic)

PS. Why do doctors do internships? The only difference between me and the people you interviewed is that a kind-hearted employer gave me a go and I then consistently applied myself to learning the electronics that was relevant to my work.

discover and to know is as natural as breathing and we become a trifle concerned when we encounter someone who appears not to be doing either! We would certainly hesitate to offer them a position on the *EA* staff, in case their complaint proved chronic!

However, K.L. maintains that we're totally astray in all this; that we're expecting the wrong things of the wrong people and then criticising them for not conforming to our own confused ideas. Don't we even know the difference between an engineer and a technician?

Who is this Leo Simpson, who "thinks himself qualified to dictate the curriculum of an engineering degree course?"

I can well imagine Leo Simpson retorting in kind: "Who is this K.L. flabbergastrian who thinks himself qualified to choose my staff for me?"

Without seeking to answer such rhetorical questions, it is interesting to highlight certain basic points from K.L.'s letter. It is reproduced in full so you can judge for yourself whether I am being anything but fair in so doing:

1. An engineer can be adequately described as a person who holds an engineering degree, in this case appropriate to the pursuit of electronics as an avocation.
2. An engineer can rightly be expected to have a sound understanding of relevant and up-to-date fundamental theory and the ability to apply it to the solution of unsolved problems, as a prime requirement.
3. An engineer has neither obligation nor need to be familiar with electronic circuit practice or terminology beyond the area in which he is currently working. He may not therefore be criticised for lack of general electronics knowledge. That's what books are for!
4. If someone is required to adapt, rework, redesign, build and test a piece of equipment, simple or complex, but using known principles, that person is doing the work of a technician.
5. Far from complementing a degree course, involvement in the hobby/general interest side of electronics is a definite disincentive which can be linked with failure ever to graduate.
6. Based on the above, it is evident that a recent graduate is unlikely to meet *EA* staff needs. *EA* editors, past and present, are not flattered by their failure to appreciate that obvious fact.

It remains to be seen whether K.L. is correct in any or all of his assertions but, in the meantime, I do wonder about some of them:

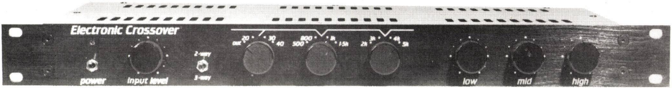
For example, he has drawn a hard, black line between engineers and technicians. Doubtless such a line exists in most structured situations, even if for organisational reasons. But is the distinction in status and duties appropriate, universal or efficient? And what about the one-time notion in the industry that a person with a diploma was commonly more "useful" than one with a degree? Are degree courses really above criticism by outsiders?

As for our own implied ignorance in the matter, I refer again to the April issue (page 29) where I discussed changes in the electronics industry over the years and the shifting emphasis in our own staff away from the purely practical approach to formal training. It's something that we've been aware of for 40 years!

Almost invariably, the "recent graduates" we have had during that time have been very successful, although we must add this qualification: they were handpicked in the first place for the depth and scope of their interests, which we took to be indicative of potential initiative and creativity in a magazine situation.

Last, but not least, there's K.L. himself. While he upholds the sanctity of an engineering degree, champions the cause of fundamental theory and relegates everyday electronics to the technician, he betrays personally an extensive over-view of the subject. Could it be that he has benefited, without realising it, from 24 years of "light" reading from *Electronics Australia?*

Next month in Electronics Australia*



Electronic crossover for active speaker systems

For many hifi enthusiasts the only way to design a loudspeaker system is to have a separate amplifier for each speaker and feed them with an electronic crossover. This 19-inch rack-mounting design is usable in two-way or three-way mode and features low noise op-amps throughout. Full details in November *Electronics Australia.*

Sound effects for model trains

Add realistic diesel sound effects to your model train layout. This circuit mounts inside the train and responds to the throttle setting.

Two low-cost audio amplifiers

Looking for a low-cost general-purpose audio amplifier? November EA has two circuits, one with an output power of 1W and the other providing up to 20W.

RAM card for the Apple II

This RAM card makes an extra 16K of memory available to the user and has a battery back-up feature to avoid repeatedly loading oft-used programs or data. It is accommodated in slot O of the Apple II series computers.

* Although these articles have been prepared for publication, circumstances may change the final content.

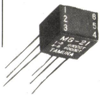
ARLEC TRANSFORMER GUIDE

O.E.M. Enquiries
welcomed

Tamura Miniature Pulse

Designed principally for computers and measuring instruments.

Type No.	Primary Inductance (uH)	Details
G 52 J12C	800	Centre tap
G 53 E21C	2500	Centre tap
G 50 J111	8	3 windings
G 51 H111	50	
G 52 E111	250	
G 52 H111	500	
G 52 J111	800	
G 73 H111	5000	
G 74 B111	12500	
G 52 E211	250	



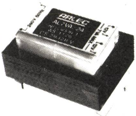
O.E.M. Enquiries
welcomed

Tamura Green Chip Series

Miniature transformers designed for transistor circuitry.

Type No	Impedance (Ω) PRI	SEC	Details
MG 24	500	50	AUDIO
MG 22	500CT	600	
MG 25	600CT	12	
MG 21	600CT	600CT	
MG 23	1K	50	
MG 17	10K CT	1.5K CT	
MG 16	10K CT	2K CT	
MG 15	10K CT	10K CT	
MG 14	20K CT	1K CT	
	Inductance		
MG 106	0.I.H.		Inductor

Low Profile



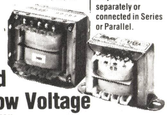
AL 7 VA Series. Insulated to AS 3126. P.C.B. mounting pins compatible with other current models and provision for additional anchorage to PCB's. 240V, 50HZ PRIMARY.

Type No.	VOLTS	SECONDARY AMPS	Details
AL 7VA/30	30	.23	2 equal secondaries for - Series - Centre Tap or Parallel Connection.
AL 7VA/24	24	.29	
AL 7VA/18	18	.39	
AL 7VA/15	15	.47	
AL 7VA/12	12	.58	
AL 7VA/9	9	.78	
AL 7VA/6	6	1.17	

P.C.B. Transformers

250V 50 HZ PRIMARY

Type No.	VOLTS	POWER VA	Details
75000 Series	2, 12V	1, 2, 5, 7, 10, 12	2 Secondaries May be used separately or connected in Series or Parallel.



Low and Extra Low Voltage

240V 50 HZ PRIMARY

Type No.	VOLTS	SECONDARY AMPS	Details
2150	12.6CT	1.25	
2155 A	8.5, 9.5 12.6CT, 15CT	1	
5502	44CT	1.25	
5504	15	2	
5508	12.6CT	2	
5579	6.3	1	
5755	40CT	1.25	
6474	12.6CT	0.15	
6625	25	0.5	
6672 A	17.5, 20, 24CT, 27.5CT 30CT.	1	
6978 A	9, 10.5, 12.6CT, 15CT	2	
7309	12	2.5	
7310	24	1.25	
60817	24	1.25	
5503	11.5, 17	4	
7243	19, 33, 40, 50CT	2	
7311	24	4.2	
9583	10.9, 18.5 × 2	4.7, 0.87 × 2	
60202	17.5, 20, 24CT, 27.5, 30CT	3	
60203	30CT, 40CT 50CT, 60CT	2	Two secondaries can be series or parallel connected.
60291	25.2CT	3.5	

Type No.	VOLTS
60202	2.5, 3, 3.5 4, 5, 5.5, 6 6.5, 7.5, 8 9, 10, 12, 12.5 15, 17.5, 18, 20, 24, 27.5, 30.
60203	5, 10, 15, 20, 25, 30, 45, 50, 55 60
2155 A	1, 1.2, 2, 2.2, 2.4, 3.1, 3.2, 4.1, 5.1, 5.5, 6.3, 6.5, 7.5, 8.5, 8.7, 9.5, 12.6, 15.
6978 A	1.2, 1.5, 2.1 2.4, 2.7, 3, 3.6, 4.2, 4.5, 5.1, 6, 6.3, 7.5, 8.7, 9, 10.5, 12.6, 15.
6672	2.5, 3, 3.5, 4, 5, 5.5, 6, 6.5, 7.5, 8, 9, 10, 12, 12.5, 15, 17.5, 18, 20, 24, 27.5, 30.

Thyristor (SCR) Trigger Transformer

For power supplies lamp dimmers, motor speed controls.

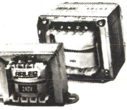
Type No.	VOLTS
XT 1185	415 (Max voltage between windings)

ARLEC

HEAD OFFICE VICTORIA
30-32 Lexton Road, Box Hill, Vic. 3
Ph: (03) 895 0222. Telex: 32286

NEW SOUTH WALES
47 Drummond St. Belmore N.S.W.
Ph: (02) 789 6733. Telex: 22874

WAGGA
K.J. Warden (Agencies) Pty. Ltd.
7 Nortan Street, Wagga, N.S.W. 2650
Ph: (069) 21 2735. Telex: 69960



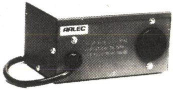
Multi Tap

General purpose transformers for special projects and experimental work provide a wide choice of output voltages. 240V. 50HZ PRIMARY.

SECONDARY AMPS	Details
3	Centre tapped 5V. 24V. 30V.
2 Amp Series 4 Amp parallel	Centre tapped 10. 20. 30. 40. 50 and 60V.
1	Centre tapped 2. 12.6 and 15V.
2	Centre tapped 3. 12.6. and 15V.
1	Centre tapped 5. 24 and 30V.

SECONDARY
Max. SCR
AMPS

70



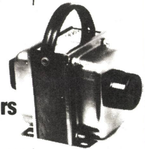
Enclosed Stepdown Transformers

240V, 50 HZ PRIMARY

Ideal for garden lamps, pond lights and water pumps, automatic trouble lamps, safety lights, pool lighting etc.

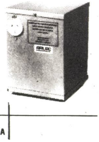
Type No.	VOLTS	SECONDARY AMPS	Details
60269	32	2.25	Type No. 60280, 60426, and 60480 have two fuses in the secondary output for pool lighting applications.
60279	32	7.8	
60280	32	5.9	
60425	24	3	
60426	24	7.9	
60453	12	6	
60480	12	15	

Portable Stepdown Transformers



Type No.	VOLTS	SECONDARY AMPS	Details
PT 5578	115	0.35	For shavers, radios. tape recorders, heating blankets, TV receivers appliances and instruments
PT 2164	115	0.87	
PT 2166	115	2.17	
PT 2168	115	4.35	
PT 2170	115	8.7	2 Pin socket.
PT 9585	240	1	For T.V. servicing, electronic workshops etc. 3 Pin socket.
PT 9789	240	2	

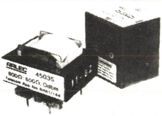
Constant Voltage



Isolated, constant RMS Voltage output.

Type No.	INPUT VOLTS	OUTPUT
CV 9024	190-260 RMS	240V-1A
CV 9027	190-260 RMS	240V-4.17A

Audio



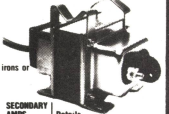
Type No.	PRIMARY IMPEDANCE	POWER	Details
45012	70/100V Line: 4/8/16 ohm	1/8-4 WATTS	Line to speaker impedance/
45035 45065	600 ohm 600 ohm	odbm	PCB Mounting Telecom Approved
LT 347	600 ohm; 600 ohm.	+ 20 dbm	Line isolation to Telecom 1053, 1054.

Control Circuit

For switchboards. PRIMARY 240V 50 HZ. Insulation to AS 3126.

Type No.	VOLTS	SECONDARY AMPS	Details
PT 9169	32.24	1.88	SEC Approved
PT 9170	32.24	3.12	
PT 9171	32.24	6.25	

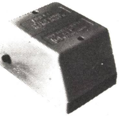
Soldering Iron



For low voltage soldering irons or similar applications.
PRIMARY 240V 50 HZ.

Type No.	VOLTS	SECONDARY AMPS	Details
60158	3.3	30 Int.	SEC Approved

Bell and Chime Transformer



PRIMARY 240V, 50 HZ.

Type No.	VOLTS	SECONDARY AMPS	Details
60999	Choice of 5, 8, 12, and 16 Volts.	1	Specially designed to power door bells and chimes. Double insulated and short circuit protected.

A.C.T.
K.J. Warden (Agencies) Pty. Ltd.
24 Geelong St. Fyshwick, A.C.T. 2609
Ph: (062) 80 5519. Telex: 62475

SOUTH AUSTRALIA
24 Maple Avenue, Forrestville, S.A. 5035
Ph: (08) 297 0766. Telex: 89234

QUEENSLAND
54 A Vernon Terrace
Newstead. Qld. 4006.
Ph: (07) 852 1131. Telex: 43263

WESTERN AUSTRALIA
611 Hay St., Jolimont, W.A. 6014
Ph: (09) 381 9834, 381 9522
Telex: 93973

TASMANIA
Launceston GHE Electronics
76 York St., Launceston, Tasmania
7250. Ph: (003) 31 6533

Hobart GHE Electronics
162 Argyle St., Hobart, Tasmania, 7000.
Ph: (002) 34 2233

Build this electronic multimeter

These days many people want a digital multimeter but they are not the best tool for all measurements. Here is an analog alternative to the digital multimeter which offers better bandwidth and simple circuitry.

by FRANCO UBAUDI & LEO SIMPSON

Commercial multimeters tend to fall into two classes. Either they are digital models with all the bells and whistles or they are simple analog instruments which suffer from a relatively low input impedance, depending on the range in use.

Now we're offering an easy-to-build alternative: an electronic multimeter. It uses an analog meter movement driven by one FET-input op amp. Building it will only take a couple of hours and there is a minimum of wiring. In the process you will gain a good insight into the workings of multimeters.

The functions offered by our multimeter are the usual AC/DC voltage, current and resistance measurements. The voltage ranges for AC and DC are 1V, 10V, 30V and 100V. For current measurement (AC or DC), the ranges are 100mA, 10mA, 1mA and 100μA. Finally, the Ohms ranges are 1kΩ, 10kΩ, 100kΩ and 1MΩ.

The performance specifications for the electronic multimeter are shown in an accompanying panel. As shown, the performance is adequate for most hobbyist measurements but in one respect it is vastly superior to the average digital multimeter.

It has a much wider frequency response than all but a few of the best digital meters.

The circuit

Even when produced by the best draughtsman (ours), multimeter circuits look confusing. All those switches and resistive dividers make the circuit look a lot more complicated than it really is.

To make the circuit easier to understand it is best to split the circuit up into its various functions. Fig. 1 shows the first function: DC voltage measurement.

DC voltage measurement

Fig.1 consists of an operational amplifer IC driving a meter movement and a few low value resistors.

The resistors connected to the non-inverting input of the op amp are the input voltage divider. In the full circuit diagram there are actually seven resistors in the input voltage divider but we have shown only two, for simplicity.

Since the op amp is a FET-input type, the current which can flow into or out of the op amp inputs is exceedingly small, much less than one nanoamp. This means that the op amp itself will cause negligible loading on the input voltage divider even though it has a total resistance of about ten megohms.

So what does the op amp do? It is like any other op amp which has feedback applied around it. It operates so that its two inputs have very little voltage difference between them. This means that the voltage at the inverting input is almost identical to that at the non-inverting input.

But note that the resistors connected to the inverting input have a very low value (relative to those at the non inverting input). This means that IC1 acts as a voltage-to-current converter with the current through the meter movement being precisely defined by the voltage applied to the input voltage divider.

At full scale deflection, the voltage at the non-inverting input of IC1 is 200mV (by virtue of the input voltage divider). This means that a current of 200/166.4 milliamps (1.2mA) will flow through the resistor string connected to the inverting input. This current is shared by the 1mA meter movement and the calibration shunt trimpot which takes 0.2mA. (See main circuit.)

AC voltage measurement

Now have a look at Fig.2. This shows how Fig.1 has been modified to take care of AC voltage measurements. First, there is a capacitor in series with the input voltage divider. This prevents DC voltages from being fed to the op amp non-inverting input.

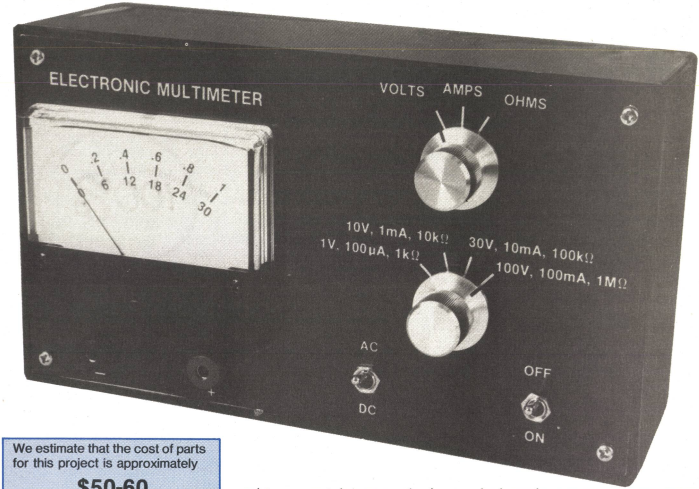
Second, the meter is connected within a bridge rectifier so that it can respond equally to positive and negative currents generated by the op amp response to positive and negative input voltages (ie, AC voltages).

Having the meter and bridge rectifier within the op amp feedback loop means that the voltage losses and non-linearity of the bridge rectifier are neatly cancelled out by the feedback mechanism. However, this does not overcome all the problems of reading the value of an AC waveform. AC voltmeters are normally required to indicate the RMS value of a sine wave signal. However, moving coil meter movements respond to the average value of their driving current. The average value of a sine wave voltage (or current) is very close to 90% of its RMS value. Accordingly, for our op-amp circuit to read sine wave signals correctly, the value of the current sink resistor must be reduced by 10%, to 150Ω.

If we now refer to the complete circuit diagram, we can further discuss the input voltage divider. This provides four ranges using seven resistors. This may seem a little odd at first but has been done this way to avoid using parallel combinations of resistors while still using values that are readily available.

Note that each resistor in the voltage divider chain is bypassed with a capacitor which is inversely proportional to the value of the resistor. Why is this necessary? After all, the LF351 op amp by itself will have a very good frequency response, because of the low "closed loop" gain.

The trouble is that stray capacitance in the switch wiring and between the input pins of the op amp itself (typically several picofarads) inevitably causes high frequency losses. This stray capacitance



We estimate that the cost of parts for this project is approximately

$50-60

This includes sales tax.

is swamped out by the capacitors shunting the voltage divider.

To this end, the highest value resistor in the divider chain is shunted with a 47pF capacitor. The capacitors shunting consecutive divider resistors increase by the same proportion as the ratio between consecutive ranges. The total effective capacitance of the capacitors shunting the divider string (not including the 3.3MΩ resistor) is 36pF which gives a time-constant for the divider of 248µS.

To nullify the severe high-frequency roll-off effect that this time constant would otherwise have, the 3.3MΩ input resistor is bypassed with a parallel combination of a 68pF capacitor and 10pF trimmer. This enables the AC performance of the circuit to be optimised for flat response to beyond 250kHz.

Current measurement

Now take a look at Fig.3: This is a combination of Figs.1 and 2, and provides us with a basic circuit with which to discuss the current ranges. The resistor connected between the input switch wiper and ground is a "current shunt". This resistor is switched, on the main circuit diagram, by S2c.

Four values of shunt resistance are provided: 2kΩ, 200Ω, 20Ω and 2Ω. Given the basic 200mV sensitivity of IC1 for full-scale deflection of the meter, the current ranges are 100µA, 1mA, 10mA and 100mA.

Note that since the values of the current shunts are low in value, there is no need for AC compensation capacitors as are required for the AC voltage measurement mode. For sine wave currents the bandwidth of the meter circuit is flat to 75kHz.

Resistance measurement

Fig.4 shows the basic circuit for resistance measurement. While this looks quite different from the previous circuits, the mode of operation is really just another variation. The main difference is that it incorporates a constant current source, which is depicted by the overlapping circles symbol.

A constant current source is the complement of a constant voltage source. Whereas, in theory, a constant voltage source maintains the same output voltage regardless of how low the load may be, a constant current source maintains the same output current, regardless of the value of series resistor it may be feeding.

The constant current source feeds the resistor which is connected across the input terminals of the instrument. The constant current develops a voltage across the unknown resistor and this is measured by the meter circuit to give the value in "ohms". Simple.

In practice, the constant current source is a three-terminal semiconductor device, the National Seminconductor LM334. This is connected to a number of adjustable switchpots by S2b, on the main circuit diagram. These are adjusted to give four fixed currents of 4µA, 40µA, 400µA and 4mA.

Now we note another difference in the resistance measuring circuit. The resistor string connected to the inverting input of IC1 has been increased by the addition of 3.3kΩ (which is switched by S1d on the main circuit diagram). This additional resistor increases the input voltage for full-scale deflection to 4 volts (instead of 200mV, as before).

Combined with the four fixed currents noted above, this gives resistance measurement ranges of 1kΩ, 10kΩ, 100kΩ and 1MΩ.

Build this electronic multimeter

Note that the AC/DC switch (S3) must be in the DC position for a resistance measurement to be made. If S3 is in the AC position the meter pointer will be fully deflected.

Having explained each of the circuit functions in turn, there is not much left to discuss of the complete circuit

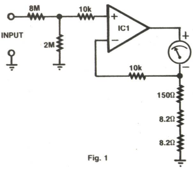


Fig. 1

Fig.1: basic DC voltmeter. Input impedance is close to 10MΩ.

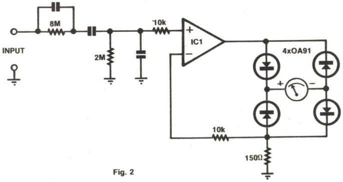


Fig. 2

Fig.2: this is how the circuit is modified for AC voltage measurements.

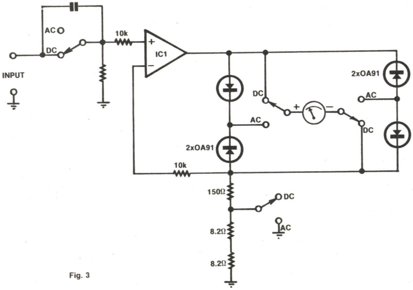


Fig. 3

Fig.3: basic current measurement circuit. Note the shunt resistor on the input.

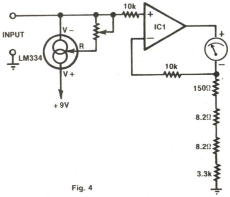


Fig. 4

Fig.4: resistance measurements require a constant current source (LM334).

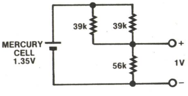


Fig. 5

Fig.5: this accurate 1V reference uses a mercury cell and 1% resistors.

PARTS LIST

1 PCB, code 84vm10, 104 x 106mm
1 Scotchcal label, 191 x 107mm
1 plastic zippy case, 60 x 113 x 196mm
1 panel meter, 0-1 mA, 80 x 66mm
1 4-pole 3-position rotary switch
1 3-pole 4-position rotary switch
1 2-pole 2-position toggle switch
1 4-pole 2-position toggle switch
2 probe sockets, one red & one black, 4mm
1 set of probe test leads
2 9 volt transistor batteries + clips
2 knobs

Semiconductors

1 LF351, TL071, FET-input op amp
1 LM334 3-terminal adjustable current source
4 OA91 germainium diodes or similar
1 1N4148, 1N914 diode

Capacitors

2 100μF/16V PC electrolytic
1 0.1μF/600VW polycarbonate
3 0.1μF metallised polyester (greencap)
1 .01μF metalised polyester
1 .0047μF metallised polyester
1 .0015μF metallised polyester
1 470pF ceramic
1 150pF ceramic
1 47pF ceramic
1 68pF ceramic
1 10-40pF miniature ceramic trimmer

***Resistors** (1%, ¼W unless noted)*

1 × 4.7MΩ ½W, 1 × 3.3MΩ ½W, 1 × 1.5MΩ, 1 × 330kΩ, 1 × 130kΩ, 1 × 47kΩ, 1 × 20kΩ, 1 × 3.3kΩ, 1 × 1.8kΩ, 1 × 180kΩ, 1 × 150kΩ, 1 × 18kΩ, 2 × 8.2kΩ, 1 × 2kΩ.

***Resistors** (5%, ¼W)*

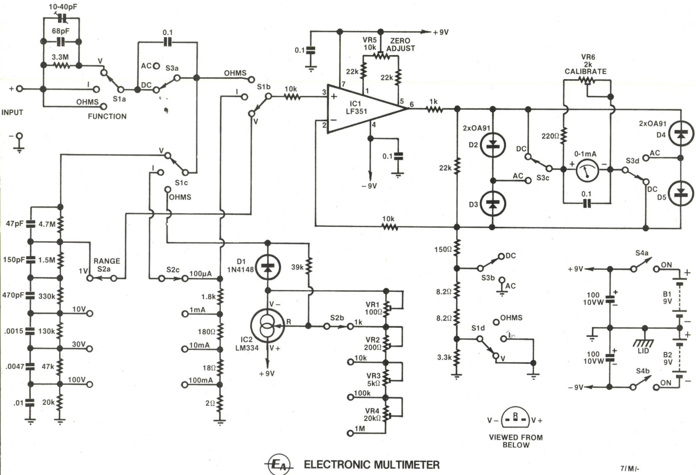
1 × 39kΩ, 3 × 22kΩ, 2 × 10kΩ, 1 × 1kΩ, 1 × 220kΩ,

Trimpots

1 × 20kΩ, 1 × 10kΩ, 1 × 5kΩ, 1 × 2kΩ, 1 × 200Ω, 1 × 100Ω

Miscellaneous

4 rubber feet, 1 battery bracket (aluminium strip 120 x 20mm), nuts & bolts, hook up wire, tinned copper wire, solder.



The circuit is essentially a combination of Figs.1-4, with some additional refinements.

diagram. There are some components which should be mentioned though. The irst of these are the 10kΩ resistors in series with the input leads to the op amp, IC1. These are to prevent gross overload o the IC, in the event of the wrong ange being selected.

Similarly, the 1kΩ resistor in series with the output, pin 6, of the op amp, is here in case the op amp is being overdriven and may be overdriving the meter as a result. The 1kΩ resistor limits the current to a safe value.

A trimpot network is connected between pins 1 and 5 of IC1 to provide a zero adjustment for the meter.

Finally, the 22kΩ resistor across the bridge rectifier is provided so that a eeback current always flows around C1, even when the output voltage of the ircuit is insufficient to make the diodes conduct.

Construction

Assembling this project is easy. All the parts, including the switches, are mounted on the printed circuit board which measures 104 x 106mm and is oded 84vm10.

First step in assembly is to install all the links and small components such as resistors and diodes. Note that most of the resistors are 1% types with only a few non-critical values being 5% tolerance.

With the small components installed, the capacitors, trimpots and switches can be mounted. Finally, the op amp and LM334 current source can be installed.

Calibration

This task must be performed before the PC board and meter is assembled into the case. You will need an accurate DC voltage source, an audio oscillator which can range up to 300kHz or more and a number of accurate resistors.

Perhaps the cheapest and most readily available accurate DC source is a mercury button cell, as used in many cameras and digital clocks. These cells have an output voltage of 1.35V over most of their operating life and cost only a few dollars. If you already have one in

Specifications

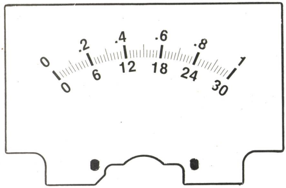
Voltage	
DC & AC ranges	1, 10, 30, 100V FSD
Input impedance	10MΩ//27pF
Accuracy	± 5% FSD for AC and DC
Bandwidth:	−3dB at 13Hz & 250kHz
Current	
DC & AC ranges	100µA, 1mA, 10mA, 100mA FSD
Input impedance	2kΩ, 200Ω, 20Ω, 2Ω
Accuracy:	± 5% FSD for AC and DC
Bandwidth:	−3dB at 25Hz & 75kHz
Burden voltage:	200mV
Resistance	
Ranges	1kΩ, 10kΩ, 100kΩ, 1MΩ
Accuracy	± 5% FSD

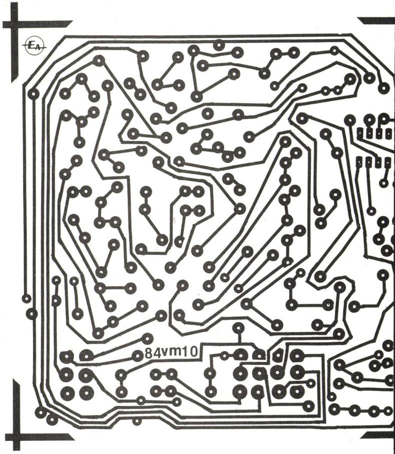
your camera you are set.

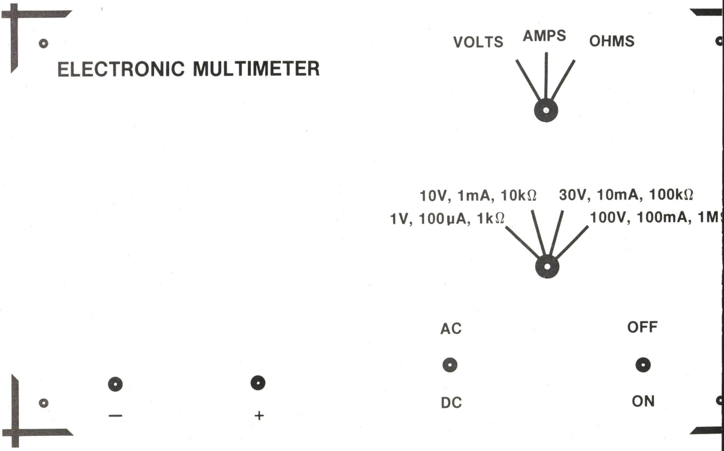
Fig.5 shows how a mercury cell can be connected into a circuit to give a voltage very close to 1V. 1% resistors must be used here.

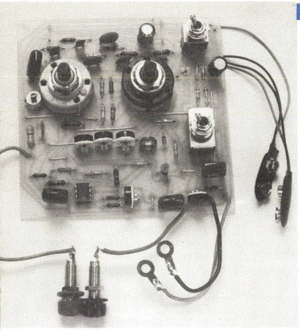
First step in the calibration procedure is to mechanically zero the meter. This is done before power is applied. If the pointer is not exactly at zero adjust it by

Here are actual size artworks for the meter scale, PC board and front panel.

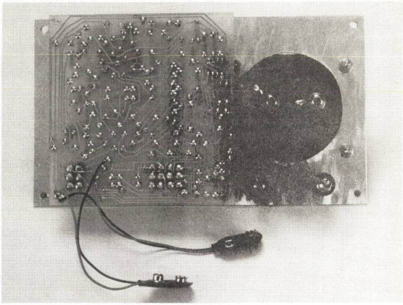




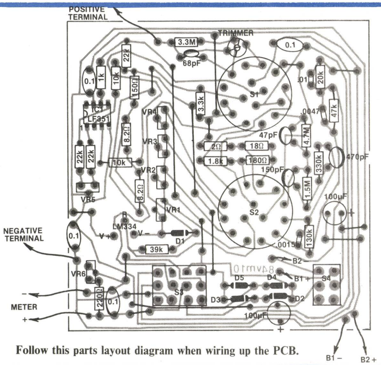




Most of the parts are mounted directly on the PC board.



The PC board is supported on the front panel by the switches.



Follow this parts layout diagram when wiring up the PCB.

turning the plastic screw on the front of the meter case.

Now turn the power on with the function switch selected to "volts". If the needle is no longer pointing to zero, use the zero adjust trimpot near the op amp to zero the needle. Once the needle is zeroed, apply a known DC voltage (see Fig.5) and check the performance of the multimeter. If the multimeter continues to read zero, you may have the AC/DC switch set to AC.

Note that only one calibration adjustment is provided for AC and DC volts. If you have an audio oscillator you can use it to set the compensation trimmer. Set the oscillator to around 1kHz or so and set the meter range to suit the output of the oscillator which should be ideally around 10 volts.

Now you engage in a repetitive procedure to obtain the flattest and most extended AC frequency response. Set the oscillator to a frequency of around 200kHz and adjust the trimmer to give the same reading as at 1kHz. (We assume that the oscillator has a constant output over its whole operating range). Now increase the oscillator to 300kHz and check that the meter reading is the same and not higher.

Try adjusting the trimmer to give the same result as at 1kHz and 200kHz but note that if you over-compensate the reading at 200kHz it will be higher than that at 1kHz and 300kHz. A number of spot checks will be necessary to obtain the flattest and most extended response.

We are now ready to carry out the final setting of the multimeter. What we are going to do now is trim the four current setting trimpots. For this you will need four resistors: 1kΩ, 10kΩ, 100kΩ and a 1MΩ. Note that the ultimate accuracy of the multimeter is determined by the tolerance of the resistors you use for this exercise.

Set the multimeter to ohms measurement and the range to 1kΩ. Make sure the AC/DC switch is selected to DC. Now attempt to measure the resistance of the 1kΩ resistor. Using a screwdriver, adjust VR1 to give fsd (full-scale deflection). Next switch the range to 10kΩ and insert the 10kΩ resistor between the probes of the multimeter. Adjust VR2 to give fsd. Repeat the process for the 100kΩ and 1MΩ ranges (ie, VR3 and VR4).

Final assembly

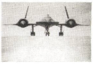
When the calibration has been performed, the meter may be assembled into the case along with the PC board. Before that can be done the Scotchcal label (if you have made or purchased one) should be affixed to the lid of the zippy box. With that done, you will have to drill the front panel holes and make the meter cut-out.

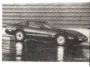
Use the wiring diagram as a guide to help in the final assembly and wiring. The order of assembly is to mount the meter first, then the PCB and lastly the probe sockets.

JAYCAR

NEW - "HI-TECH" WALL POSTERS

A departure from our area of electronic hardware, but we think that you will be as impressed as we were when you see these magnificent posters. Shown below are descriptions of a small range of posters. We may increase this range depending on the response.





BOEING 767 COCKPIT A magnificent wide-angle view of a new Boeing 767 flight deck on the tarmac at dusk. The photograph is taken from the entrance to the flight deck. In the foreground is a clear view of the new all-electronic instrumentation which is a feature of this aircraft. On the far right is the engineer's console. A typical airport runway can be seen through the pilots windscreen. Full technical specs appear on the bottom edge of the 530(H)x 825(W)mm poster, which is printed in full colour on art paper.

Cat. BP-9210 —————— $5.95

SR-71 "BLACKBIRD" Reconnaisance aircraft This is a superb front-on shot of the super-secret SR-71 standing on a remote runway. The photograph clearly illustrates the very low Cd of this aircraft, which can fly higher and faster than virtually any other. A truly remarkable example of High-Tech despite the fact that it was designed many years ago now. Once again, full 530(H)x825(W) colouor. (The aircraft is painted black).

Cat. BP-9212 —————— $5.95

"LAMBORGHINI" How could you ever be upstaged in a Lambo? Well if you haven't got the $A200 grand that one will cost you here you can have a magnificent poster of a red Countach for $5.95. This 530(H)x825(W)mm poster shows this classic vehicle contemptuously parked across the yellow line of a lonely road.

Cat. BP-9214 —————— $5.95

"CORVETTE" This is a photograph of the 1984 model Corvette. This model was completely re-engineered and is a major departure from conservative engineering practice. Many European style mechanical features around. It is rumoured that they may arrive in Australia in numbers. . . We think that it is the best-looking example of the marque yet. The car is painted in black against a red background. 530(H)x825(W)mm.

Cat. BP-9216 —————— $5.95

Buy any 2 of the 4 posters for only

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GETTING STARTED ON YOUR MICROBEE

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ONLY $12.50

Fantastic new book for Microbee newcomers! A typical "Everything you wanted to know. . ." book with chapter headings such as: ☆ *Starting out* ☆ *Putting things on the screen* ☆ *Changing in mid-stream* ☆ *Getting into music* ☆ *Adding life to programs* ☆ *14 chapters in all!!*
Contains many simple programs! Cover 250 x 180mm. 105 pages.

$3.95

PCB MOUNT SAFETY SPEAKER CONNECTORS
Brilliant new component - as used in the latest Perreaux and Yamaha amps. Modern high power amps produce voltages at the speaker terminals which can give a nasty shock. The new PT-3010 efficiently connects and insulates the exposed speaker wire. The bare wire is simply inserted and the plastic shroud twisted. The connector is capable of panel mounting and is ideal for PCB termination with panel fixing. The PT-3010 is supplied as two rows of alternate black and red twist terminals.

Cat. PT-3010

16 WAY RCA INPUT JACK PANEL
Fantastic. PCB terminals, panel mount. FEATURES: ★ Right and Left input jacks in different colours to assist identification ★ Earth binding post included ★ 2 rows of 8. Can be snapped apart (vertically) for smaller configuration.

Cat. PS-0280

$3.95

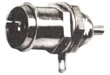
GRADUATED KNOB WITH SKIRT
Similar knob to illustration except that skirt has aluminium skirt with graduations 0-9 with smaller scale markings in between. The supplier Boo-Boo'ed and we got them! Will take ¼" shaft and has retaining grubscrew.
TOYA TYPE TK 167B ——————

1-9 50¢ ea
10+40¢ ea
Normally $1.50 value!

NEW High Quality Belling-Lee (PAL) 75 ohm Socket

At last! A decent quality 75 ohm socket for wall outlets and other TV/Video applications. We were sick and tired of the poor quality 75 ohm wall sockets which abound. You know the ones formed out of tinplate that give intermittent connections after about 3 insertions. . . We have finally sourced a recepticle that is machined out of one piece of spring brass, is heavily plated and will last a lifetime. It even has a special circlip around the outer pole to ensure that consistent pressure is maintained to the connecting plug.

Cat. PS-0628 —————— $1.95 ea 10+ $1.60 ea

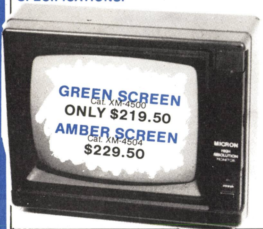


HIGH RESOLUTION GREEN & AMBER SCREEN MONITORS

NEW MICRON SERIES II

- 1050 lines resolution centre screen
- 22 MHz bandwidth
- Video input switch for networking
- Non glare high grade monitor tube

SPECIFICATIONS:



GREEN SCREEN
Cat. XM-4500
ONLY $219.50
AMBER SCREEN
Cat. XM-4504
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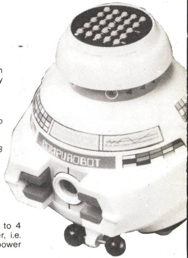

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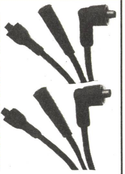

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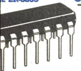

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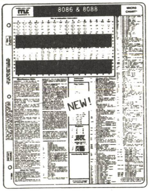

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REVIEWS OF RECENT RECORDS AND

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RACHMANINOFF

Piano Concerto No. 2 in C Minor. Rhapsody on a Theme by Paganini. Cecile Licad (piano) with the Chicago Orchestra conducted by Claudio Abbado. CBS Masterwork D 38672.

In their sleeve notes at the back of the recent issue of the Rachmaninoff's C Minor Piano Concerto by the 23-year-old Filipino-born pianist Cecile Licad, CBS rightly claims the girl discovered in her first recordings as a "significant new talent."

She opened her recording career with a work very popular with the average concert-going public — indeed two works with the Paganini Variations the latter a favourite with competitors aspiring to honours in piano competitions. In the August issue, I reviewed a persuasive performance of the C minor so that it is now interesting to compare the two.

Ms Licad's photograph on the record sleeve shows an attractive Asian face and a pair of very useful-looking but shapely pianist's hands. The work is digitally recorded using the Soundstream system — whatever that might be. For the benefit of those who happen to know the following credits are given on the bottom right-hand corner of the back of the sleeve: Jack Renner (sound engineer), Jules Bloomenthal (digital engineer), Henrietta Condak (arts direction). Digitally recorded using Soundstream system, Neotex mixing console, and Shoeps microphones.

While on the subject of such details I would like to express the average buyer's discomfort with the tiny print used on the record label, so small that a magnifying glass is needed by all but the the keenest sight to read it.

In the very first pianissimo passage, Ms Licad promises great virtuosity, a promise that is always fulfilled during the rest of the concerto. Very impressive to us, too, was her intensively lyrical — but logical — nuancing of the slower second subject.

The orchestra is occasionally a little too forwardly recorded but is notable for a beautifully mysterious-toned horn solo in the first movement. However, the dynamic range is more merciful to the listener than a great many other digital recordings.

Ms Licad has her own ideas about tempos which are never bizarre or youthfully obstinate. Her's is an impressive debut with the orchestra sometimes rising to a compelling surge to match her fresh young emotional climaxes.

Despite her brilliant virtuosity in the second movement it was slightly marred for me by the piano figuration which sometimes covers the orchestra. I liked the great Ashkenaazy's performance so little that I much prefer the one under review. And I must add that there is some lovely playing from the orchestra when they have things on their own.

On the second side are the Paganini Variations which start at a good steady fast pace but tend to become a trifle overdone. It all sounds just like players enjoying their own skill. The balance between soloist and orchestra is consistently better than in the concerto and there are always splendid contrasts among the many different episodes.

The digital recording is first rate. The brass is a wee bit sharp-toned but the strings have a more luscious quality than might often be found in similar recordings. The piano is completely lifelike and the work finishes with a grand climax. A really great new talent indeed. (J.R.)

RICHARD STRAUSS

Also Sprach Zarathustra, Don Juan, Berlin Philharmonic Orchestra conducted by Herbert von Karajan. DGG/digitally Recorded 410 959-1

In his eminently sane and perceptive sleeve notes to this disc William Mann, well known to Australian audiences, writes: "Also Sprach Zarathustra is no portrait, but a musical response to Nietzsche's philosophical rhapsody of that title which was published complete in 1892. In the tone poem Strauss contrasts man and nature by reference to the adjacent, yet diatonically remote keys of B major and C minor."

He goes on to list the movements under some of Nietzsche's chapter headings with a brief comment on each. He nowhere states whether or not Strauss's musicalisations are successful though his deep respect for the composer and parts of the work is always evident.

Karajan brings blazing enthusiasm to the great opening "yea-saying" theme, nowadays, alas, debased by use as background music to advertise a range of common commodities from toilet paper to ice cream. Opinions differ on the "hidden meanings" of Nietzsche's philosophical rhapsody although the author was shouting as plainly and as loudly as he knew how. And Strauss himself would argue for hours, equating the philosopher's Superman with Wagner's bully-boy Siegfried.

I don't know Karajan's opinion of Nietzsche's philosophy but his direction of the music under review is glorious. The opening is as resounding as Nietzsche's himself, followed immediately to Nietzschean scorn for mankind's grovelling respect for God and religion. This Karajan treats with the greatest effort to dignify sweetness — and is very successful.

Karajan's reading may be a trifle uncertain in irony despite the glowing sound of the climax. Here is superb, exciting music composed when most of the 12 note-boys — Schonberg and the 2nd Vienna School — were still wetting their napkins.

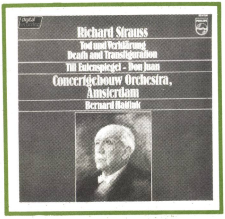
As you might gather, the work, all told, is a mixture of greatness and banality though this is not dealt with by Mann. Indeed to follow all Strauss's sub-headings you'd need a libretto. But Mann does very well using only basic headings.

The Finale, Nietzsche's profound obeisance to Joy is reflected in music strangely cheapening of the idea. In dance form it exposes Strauss at this most wheedling.

The digital engineering is splendid with a very wide dynamic range and much detail, though towards the very end the Midnight Bell produces a sort of squashed cymbal effect in the noisy climax, but rights itself in the last bars. A very impressive performance.

The digital process makes it clear just how busy everyone is in the vigorous opening bars of Don Juan on the reverse side. Yet the sound still lacks true analog bloom. Swaggering our hero might be, but the engineering robs him of much of his power of seduction. Also, intrusive timps thump away tiresomely. But I have never heard the famous oboe solo played so beautifully, or so langourously.

Tinny cymbals do nothing to help the sound and the sound elsewhere gives the effect of orchestral screeching. There is little richness despite Strauss's inspired scoring. On my pressing there is a bad blot just before the end. Check this before buying. (J.R.)


digital
Richard Strauss
Tod und Verklärung
Death and Transfiguration
Till Eulenspiegel · Don Juan
Concertgebouw Orchestra, Amsterdam
Bernard Haitink

RICHARD STRAUSS

Tod und Verklarung. Till Eulenspiegel. Don Juan. Tone Poems played by the Concertgebouw Orchestra of Amsterdam conducted by Bernard Haitink. Philips Digital 6514 228.

This combination of Strauss's tone poems has often been recorded before. Among those recommended, my favorites are Dorati with the Detroit and Abbado with the London Symphony. I am afraid that the one under review cannot be included in that company.

Perhaps this is due to faults in the digital recording or, judging by some of the enthusiastic reviews overseas, I've had the bad luck to get hold of a dud pressing. However, to confirm my opinion that it was not my equipment that was at fault I played some other discs, the quality of which I knew very well. My equipment was OK!

Before going any further I should like to state that I am a great admirer of Bernard Haitink and also of the great Concertgebouw Orchestra. Thus I was very surprised that my pressing needed much more gain than is usual, that the sound seemed shrunken with few choices between soft and loud, and Strauss's sumptuous orchestration was not realised, indeed hardly hinted at. To check on my first opinion and perhaps unfair prejudice I tried Don Juan first, with the result recorded above.

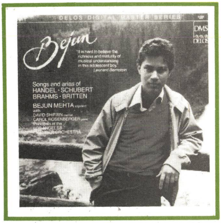
The engineering, at least on my pressing, was so poor that it was hard to judge any real merit the performance might have. Most early stereos sounded much better. At the second try, I stopped it in the middle. I can only hope that my pressing is a discard. I might add that to compound my unease the intrusive timps thudded away disturbingly throughout.

Till Eulenspiegel was better but with a giant dynamic range — between just audible pianissimos and eardrum-shattering fortussimos. The orchestra was sometimes out of balance. The strings were often drowned out by other instruments and little remained to indicate the splendour of Strauss's scoring.

Tod und Verklarung was marred by some early background noise. The dynamics were scrappy — I checked them against Jessye Norman in Wagner's Wesendonck lieder, which has a lovely bloom on the strings, and found the usual Concertgebouw warmth to be missing. I know its quality. I was at the Holland Festival just on 20 years ago as a guest of the Netherlands' government. As to the balance, while the horns' tone sounded nice and full, that of other soloists, such as the oboe, sounded rather mean. And the rest of the orchestra seemed to skip along urgently than push purposefully.

Here and there the sound was full of tinny cymbal crashes, although the death-room atmosphere was well realised — that is if you don't mind the sound naked and airless but with beautiful detail. Indeed the whole disc advertises the best and worst features of the digital process.

I am writing the strict truth when I complain that in a frustrated effort to find a comfortable setting of the gain all I won was a headache. I regret to have to write that a disc I looked forward to hearing with such pleasure should turn out to be so substandard. (J.R.)



BOY SOPRANO

BEJUN. Songs and Arias of Handel, Schubert, Brahms, Britten. Bejun Mehta, soprano, with David Shifrin (Clarinet), Carol Rosenberger (piano) and principals of the Los Angeles Chamber Orchestra. DMS Delos stereo LP D/DMS-3019. [From PC Stereo Pty Ltd, PO Box 272, Mt Gravatt, Qld 4122. Phone (07) 343 1612].

While the name Bejun may be unfamiliar, the family name Mehta should certainly not be. Bombay born, Bejun's father, Dady Mehta is a cousin of the well known conductor Zubin Mehta but, in his own right, is a teacher of piano and a performer on an international scale. Bejun's mother, Pennsylvania born, and trained as a singer in Vienna, is a singing teacher and journalist. And, to round off the family tree, brother Nuvi, six years Bejun's senior, is an accomplished violinist, with a growing interest in conducting.

Against that background, it is not surprising that Bejun should have developed an early and intelligent interest in classical music but what startled his family and acquaintenances was an innate vocal facility that others achieve only after many years of training. At age nine, Bejun began a mini-career as a boy soprano, culminating in a performance of Mendelssohn's "Elijah" with the Philadelphia Orchestra in 1982 and, in 1983, at age 14, with a solo recital with pianist Carol Rosenberger.

This recording is from that period and was issued by Delos to preserve the memory of a voice that, however impermanent, was unique in its musical maturity. Said Leonard Bernstein: "It is hard to believe the richness and maturity of musical understanding in this adolescent boy."

Perhaps it was because of the essentially impermanent nature of a boy soprano voice that I tended to approach the recording as a curiosity, rather than a performance in its own right. The boy was good, very good, but he was also something of an interloper!

Then I turned over to side 2 and to Schubert's "Shepherd on the Rock", with Carol, Rosenberger and David Shifrin, and my mental quibble was shown for what it was. Here was voice control and a maturity that might have been envied by someone twice Bejun's age!

Delos have certainly not stinted in the presentation of the album, with a beautifully printed double-fold jacket, detailed notes of the artist and his family, the composers and their music, plus the words of each item:

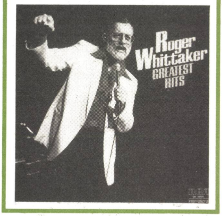
Handel: If God Be For Us — Where're You Walk — So Shall the Lute and Harp Awake — What Though I Trace — How Beautiful Are the Feet — With Thee, the Unsheltered Moor I'd Tread. Schubert: The Shepherd on the Rock. Brahms: Ladybug — My Sweetheart Has Rosy Lips — Down Deep in the Valley — A Tree is Standing. Britten: The Last Rose of Summer.

Digitally recorded in the Shatto Chapel of the First Congregational Church in Los Angeles, the sound quality is excellent but only you can judge whether you have a potential interest in the album. Sufficient to say that, if the music appeals, or you have a special interest in the artist, you won't be disappointed. (W.N.W.)

FOR WHITTAKER FANS

Roger Whittaker, Greatest Hits. Stereo LP, RCA International VAL-10429.

Without the benefit of jacket notes, one can only gather from the formal credits that the tracks on this "Greatest Hits" album have been selected by one, Ethel Gabriel, and re-issued with the support of the Roger Whittaker International Fan Club, based in London. Credited to Tembo Records, it is being distributed in Australia and New Zealand on the RCA label.



One would judge from the contents that the numbers have been selected quite deliberately, rather than simply being a string of available tracks, as on some "Greatest" or "Best" releases. They show the various sides of Roger Whittaker and the presentation is uniformly good:

You Are My Miracle — Albany — Annie's Song — Barroom Country Singer — Too Beautiful To Cry — I Am But a Small Voice — Yellow Bird — My Love, Cape Breton and Me — The Wind Beneath My Wings.

The sound and production is smooth and clean, the diction excellent and the style relaxed. If you can do with about 35 minutes of relaxing vocals, now and again, it would be a good investment. And, of course, it's a "natural" for Whittaker fans. (W.N.W.)

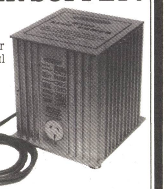
DUO PIANISTES

LISZT: Music for Two Pianos. Reminiscences de Don Juan; Two Episodes from Lanau's "Faust". Katia and Marielle Labeque. Digital, metal mastered stereo LP, EMI IC-067.

At a personal level, Katia Labeque is partial to the jazz idiom, while Marielle is more at home with chamber music. However, their talents merge easily as duo-pianistes and, indeed, they see their diversity of interest as a source of continuing inspiration and expanding ideas.

This particular recording was made by EMI in Paris, following a series of concerts in London, last year. Reportedly, the concerts were popular and successful, although the Labeque Sisters attracted some criticism for a tendency to play too fast, at the expense of the "character" of the music, and for allowing forte passages to become unduly hard and unduly noisy.

There is certainly no restraint in the



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FERGUSON

opening passage of "Reminiscences de Don Juan", on side 1. I doubt that you will ever hear more chordal sustain than is evident here from the two pianos, played loudly and simultaneously. And it is all sustain, as will be evident from the abrupt silence when the pedals are released. Whether you interpret the sound as sonorous or just plain noisy will depend, I suspect, both on your personal convictions and on the characteristics of your hifi system and listening room.

By contrast, the quieter passages which follow are delicate, with some notes played so softly that they are at risk of not being heard at all in other than a dead-quiet environment. Such is the potential dynamic range of EMI's digital/DMM LP recordings.

In her jacket notes, Joan Chissel points up the fondness of Franz Liszt for arranging piano transcriptions of other composers' works, both for personal performance, and as a way of publicising those works to audiences which, in the mid-nineteenth century, often had no other way of hearing them. Among the transcriptions were a surprising number for four hands or two pianos, and the selections on this disc are among that number. She goes on to explain something of their respective backgrounds.

Overall, the recording is not one that I could recommend without qualification. The recording quality itself is fine, with no hint of noise, overload or distortion — but the dynamic range is too great for "comfortable" domestic listening. As such, it is likely to re-echo the complaint of the critics and get in the way of the music.

Lest I appear unduly negative, let me add a couple of constructive suggestions. Move your chair closer in to the loudspeakers so that the left and right channels are more distinctive and, of course, readjust the volume to suit. Better still, if you have a pair of good quality phones, try those, making sure to put them on the right way round. You'll find yourself close in, where it's all happening, with dynamic range no longer a domestic problem. (W.N.W.)

AUSTRALIAN C&W

Easy Loving. Rex Dallas. Stereo LP album. Hadley HLP-1280. Distributed through RCA.

If you haven't previously come across the "Hadley" label, it has a direct connection with the Hadley Sound Studios located in Tamworth, NSW, billed as the "Country Music Capital of Australia. Not surprisingly, this is a C&W-style album featuring Rex Dallas. Three other records/cassettes by the same artist are illustrated on the jacket: "Here's to the Songwriter", "I Love the Old Bush Songs" and "Yodelling Mad".

In this latest album, "Easy Loving", Rex Dallas is backed by a vocalist and nine talented "country" musicians, as listed on the jacket, playing piano, violins, guitars including pedal-steel and bass, and drums. With arrangements and direction by Garry Adams, they have a smooth, cohesive sound, providing excellent backing for the vocalist.

While the setting is Tamworth/C&W, the album has nothing in common with the primitive, nasal sound sometimes affected for Australian bush songs — a sound, up with which I personally cannot put! If you would like a touch of the more "civilised" kind, have a look and a listen:

I Remember You — Bridge Over Troubled Water — Easy Lovin' — A Stranger in My Place — Begging to You — Yippi Cry I — Bluest Heartache of the Year — A Legend in My Time — And I Love You So — As Big as a River — Gonna Find Me a Bluebird.

Mastered on a 24-track analog recorder and mixed down to a Sony digital tape, the sound quality is clean and well balanced except for one thing: there is a noticeable "edge" the Rex Dallas' voice on loud, higher notes which might suggest a touch of overload on the original voice channel. Depending on your system, you may not even notice it; if you do, try a bit of top end cut. (W.N.W.)

OVERTURES

MOZART OVERTURES. Le nozze de Figaro, K492; Die Zauberflote, K620; La Clemenza di Tito, K621; Lucia Silla, K135; Die Entfuhrung aus dem Serail, K384; Don Giovanni, K527; Idomeneo, K366; Cosi fan tutte, K588; Der Schauspieldirektor, K486. Academy of St. Martin-in-the-Fields, conducted by Neville Marriner. EMI compact disc CDC-7470142.

If you choose to play this disc straight through, you will find that it will give you about 49 minutes of program, with appropriate pauses between the individual items and/or movements. You can follow it through readily with Robert Dearling's booklet notes, which offer a general introduction to the recording, followed by brief comment on each item.

However, it's a disc which lends itself no less to selective listening as, for example, to Lucio Silla, K135 — in reality a mini-symphony — or to K384 which follows it. Selection is made very easy by the compact disc, which is encoded for the beginning of each of the nine items.

What a boon it is to be able to preselect the items you fancy and then simply to sit back, relax and listen.

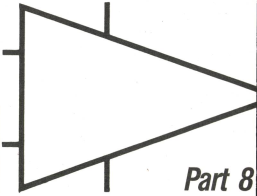
In this case, listening comes very easily, with a recording which is notable for its overall balance, its clarity, its stereo imaging and a complete freedom from any hint of edginess to complex orchestral passages. Indeed, I doubt that you'll hear recording strings to much better advantage than here.

The performance itself is as precise as we've come to expect from Marriner and the ASMF but that doesn't mean that it's in any sense clinical. The orchestra could indeed be in the pit, announcing what was to follow and anticipating the raising of the curtain.

If the music appeals, this should certainly be a candidate for inclusion in your compact disc collection. (W.N.W.)

by BRYAN MAHER

OP AMPS Explained



Part 8

Operational amplifiers can be used to perform many linear functions. This month we look at three conversion functions: voltage-to-frequency, voltage-to-period, and average frequency-to-voltage.

There are many occasions in the world of electronics when the linear conversion of a voltage to a frequency is required. By this we mean a linear circuit capable of producing an output signal, the frequency of which is directly proportional to the input signal voltage.

Such a converter enables us to perform many precision tasks including: some forms of serial digital transmission, accurate analog-to-digital conversion, integration over very long times, and evaluation of the area enclosed by waveforms. By adding a digital counter or frequency meter, we achieve an integrator or a digital voltmeter.

Observe that it is only the *frequency* of the output signal that is of interest; its voltage and waveform is a secondary consideration and anything suitable for our purpose will do.

Voltage controlled oscillator

Circuits which convert voltage to frequency in this fashion are called voltage controlled oscillators, or VCOs for short. If the input signal is a constant voltage, then the output signal has a constant frequency. On the other hand, changes to the input voltage produce a corresponding change in the output frequency.

Applications for VCOs are found in phase lock loops, (PLLs), frequency synthesisers for communications systems, synchronous modulation systems, colour television, two tone modems for telephone-computer connections, and more.

Often, a sinewave will be chosen as the appropriate output waveform, but other waveforms may also be chosen. For example, if the input voltage changes rapidly over a wide range, then a string of digital pulses may be a more suitable waveform. If the input voltage increases, more pulses-per-second are produced at the output and vice versa.

It is common to restrict the input signal to only one polarity. Some commercial VCOs are provided with two alternative inputs, the one marked negative simply feeding via a phase reversal stage to give a suitable positive input signal to the VCO itself.

Voltage to frequency conversion

The essential elements of a voltage-to-frequency (V/F) converter are shown in Fig. 1. The input signal voltage is integrated and continuously compared in a comparator or discriminator with a reference voltage. You, most avid and earnest reader, will recall that we looked

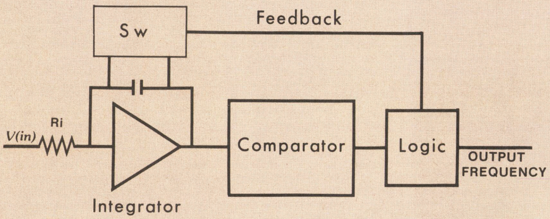


Fig.1: block diagram of a voltage-to-frequency converter. Voltage Vin is integrated and compared in a comparator or discriminator. When the reference level is reached, the logic section delivers output pulses and also sends a feedback signal to the switch Sw, which discharges the integrator ready for the next cycle. The output frequency is directly proportional to the input voltage.

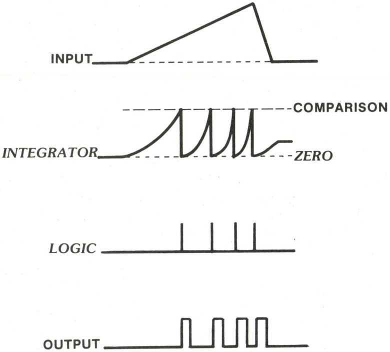


Fig.2: timing diagram for the voltage-to-frequency converter of Fig.1. Observe that a larger input voltage causes faster rise of the integral, hence greater frequency of output pulses. A logic pulse (to discharge the integrator) and an output pulse occur each time the integral reaches the comparison or reference level.

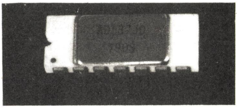


Fig.3: the Analog Devices AD537JD voltage-to-frequency converter as it arrives from the manufacturer in conductive polyfoam. The input voltage may be up to 10V while the output frequency ranges up to 100kHz. The picture is approximately twice full size.

at discriminators last month. As soon as the integral reaches the discriminator level, an output pulse is generated and the integrator is discharged to zero, ready for the next cycle. Fig. 2 is a waveform timing diagram for the voltage-to-frequency converter shown in Fig. 1.

The, higher the input voltage, the faster the integral reaches the reference level and produces another output pulse. Thus, the frequency of the output pulses is proportional to the input voltage. Because the integration function is linear, it follows that the relationship between input voltage and output frequency is also linear (provided, of course, that the reference voltage remains constant).

Because a fast changing input voltage, say an audio signal, demands that the circuit be capable of changing the output number-of-pulses-per-second just as quickly, the result is a string of short pulses, all at fixed amplitude and all with the same pulse length. It is the *number* of pulses in a given time interval that changes (see Fig. 2).

The transfer function is expressed in terms of Hertz/volt. Note that some commercial V/F converters produce an output string of true square waves; ie with a mark-space ratio 1:1.

The circuit of Fig. 1 may be assembled from discrete components or purchased from a manufacturer. Examples are the type 450 and 456 modules from Analog Devices. To produce a lower cost device, some manufacturers have produced integrated circuits containing the necessary components on a single silicon wafer, eg, Analog Devices types AD537JD and AD537SD (see Fig. 3).

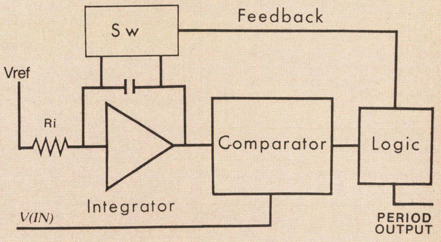


Fig.4: block diagram of a voltage-to-period converter. The reference voltage is integrated and compared with Vin. When the integral reaches Vin, the logic gives an output pulse and resets the integrator. The greater Vin, the longer the time taken by the integral. Thus the period of the output is proportional to input voltage (See timing diagram Fig.5).

By the way some workers in this field consider that the terminology is not quite correct, preferring instead the expression "voltage-to-pulse-rate converter". They argue that the word "frequency" implies a more steady value, not an abruptly changing quantity.

Another possibility, but one rarely used by electronics engineers, is to reverse the role of input and reference voltages as in Fig. 4. If we use the input voltage as the discriminator (or reference) level and integrate the reference voltage, then the period (rather than the frequency) of the output pulses will be proportional to input voltage. Fig. 5 shows the results.

Observe that in this variation the integral rises at constant slope. The higher the input voltage the longer the time taken for the integral to reach the discriminator level and thus generate an output pulse. This means of course that

OP AMPS Explained

the output pulse frequency is *inversely* proportional to the input voltage.

The transfer function of this variation is expressed in terms of microseconds per volt.

Frequency-to-voltage conversion

The inverse function, frequency-to-voltage conversion, can be achieved in a number of ways, of which we will consider two.

To stir our imagination and whet our appetite, let us embark on an excursion into the general philosophy. As we have seen earlier in this series, negative feedback systems are capable of performing many functions, for example the mathematical functions addition and integration.

We advance the philosophy one step further by saying that if we can perform some function, J, *within the feedback loop* of a suitable negative feedback system, then that whole system will perform a function which is the inverse of J. This can be written as J^{-1}, or J-inverse.

Of course to implement such a philosophy we must be able to construct a suitable negative feedback system. Our beloved op amps will do for some functions, but not for all. Fig. 6 shows the general idea.

As an aside, consider a system already known to us: the integrator of Fig. 7, in which the essential component is the capacitor in the feedback path. Now consider what we know about capacitors alone. Is it not true that a capacitor alone is a differentiating or high pass component? Fig. 8 shows a typical differentiating (or high pass filter) circuit. The current in the capacitor is proportional to the rate of change of voltage across it, or:

$$i_c = C\,\frac{dV_c}{dt}$$

where i_c is capacitor current, V_c is capacitor voltage and C the capacitance. By putting Fig. 8 into the *forward* path of an op amp, as in Fig. 9, the capacitor performs the differentiation function quite accurately, with a transfer function:

$$V_{out} = (CR)\left(\frac{dV_{in}}{dt}\right)$$

If, however, the differentiating capacitor is in the feedback path as in Fig. 7 (ie, the resistor and capacitor positions are swapped) the transfer function becomes:

$$V_{out} = \frac{1}{CR}\int V_{in}\,dt$$

This transfer function is an integration which is the complement of the function performed by Fig. 9. Indeed we can do all sorts of such "swaps" quite successfully using op amps as long as the essential functional components are passive and bilateral. Passive components are resistance R, inductance L, and capacitance C; "bilateral" means having the same current no matter in which direction voltage is applied.

Fig. 10 shows how we can play a functional inversion using an inducto forming either an integrating low pas circuit (Fig. 10a) or a differentiating hig pass circuit (Fig. 10b), according t whether we place the inductor in th input or the feedback paths.

Attempts to generalise suc philosophy to a circuit capable o inverting *any* given function may tur our present exultation into a whimpe For returning to the problem of findin an inverse to the voltage-to-frequenc function, we observe that our V/ converter is neither passive nor bilatera It is very much an active circuit.

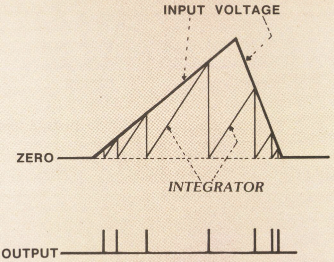


Fig:5. timing diagram for the voltage-to-period converter of Fig.4. When a constant voltage reference is integrated, the integrator output is always a constant slope as shown. Each time this slope reaches the input voltage, an output occurs. Thus, higher input voltage causes a longer output pulse period; ie, the output frequency is inversely proportional to Vin.

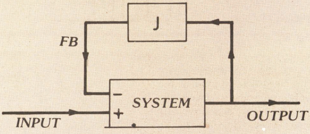


Fig.6: linear feedback system to invert function J. If we place the function J in the feedback loop, then the transfer function from input to output is J^{-1}.

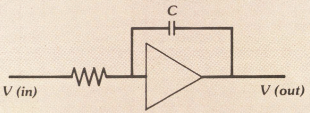


Fig.7: Simple integrator circuit. Observe that the feedback component, capacitor C, is actually a differentiating component.

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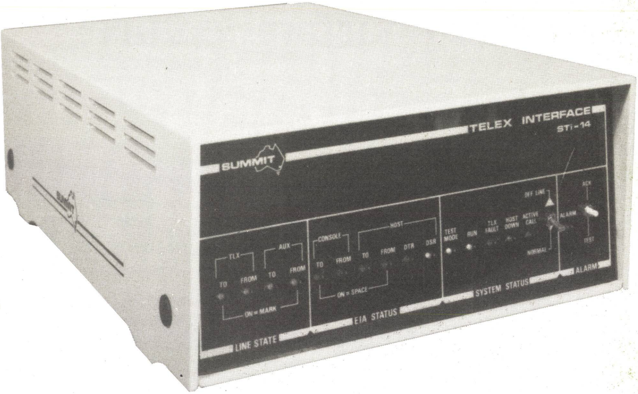

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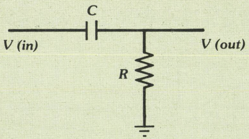


Fig.8: using a capacitor as a coupling element gives a high-pass or differentiating effect.

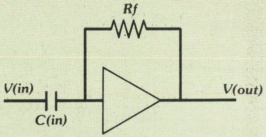


Fig.9: a capacitor in the input or forward path of an operational amplifier makes an accurate differentiator. Note that Figs.7 and 9 perform complementary functions using the same components but C and R transposed.

OP AMPS Explained

We need to find some other linear feedback system (not an op amp) that will produce the inverse frequency-to-voltage (F/V) function and which uses our aforementioned voltage-to-frequency converter in the feedback path. Fig. 11 shows our voltage-to-frequency converter connected in the feedback path of a phase comparator. The result is an output voltage that is directly proportional to the input frequency.

What happens is that the phase comparator (which may be an XOR gate with a filter) compares the signal frequency with the output from the V/F converter and produces a control voltage to bring the V/F converter into lock (ie, to the same frequency). The complete circuit is called a phase lock loop and it functions very effectively as a frequency-to-voltage converter.

We promised to consider two methods, so let's turn our eager minds to the alternative.

Average frequency to voltage

Often the frequency of a stream of pulses will be quite erratic, as when produced by some random process. We might, for example, wish to measure an industrial radioactive process, or the "firing" of a single live animal nerve cell. In these circumstances, we need to derive a voltage that is proportional to the average input pulse frequency.

Note that if the pulse rate is very low — a few pulses per second, say — then the averaging process will have to be carried out over a considerable period. We need a time constant built into our circuit. Such a design is often called an averaging (or integrating) *ratemeter.*

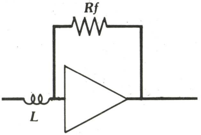


Fig.10a: an integrator using an inductor in the op amp input circuit.

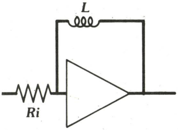


Fig.10b: a differentiator using an inductor in the feedback path. An example of functional inversion, the effect is the complement of the component's natural effect.

The design we will consider uses operational amplifiers in a linear "leaky integrator" configuration. Fig. 12 shows the block diagram.

Block diagram

The first stage consists of a precision pulse generator which generates fixed 28V pulses from a TTL input. These pulses are then differentiated by C_i and the resulting negative-going spikes used to charge capacitor C_T. The positive going spikes are blocked and bypassed to ground by the two diodes.

The charge across C_T tends to "leak away" via R with time constant RC_T, where R is a 1MΩ resistor. Hence the term *leaky integrator.*

Note the resistor in series with C_i. Its job is to prevent slew rate limiting in Q1 which would otherwise attempt to charge C_T at an infinite rate.

Let's now define a few terms:

- Let q be the amount of charge (in couloumbs) contained in each "pumping pulse" dumped into "tank" capacitor C_T.
- Let f be the average input pulse frequency (also the pump pulse frequency).
- Let V_T be the voltage on C_T.
- Let R be the resistance of the leakage path discharging C_T.

It follows that the fq product equals the average current flowing into C_T (one couloumb per second equals one ampere).

The current "leaking away" from $C_T$via R is simply given by V_T/R. When equilibrium is reached (after a number of

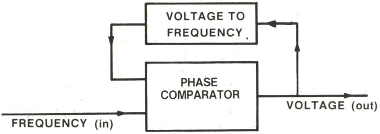
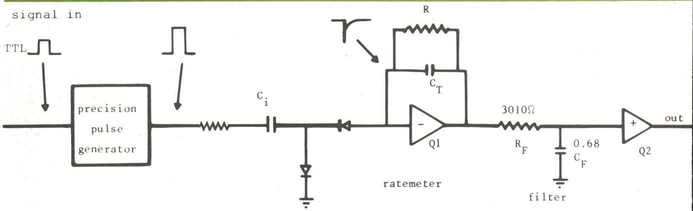


Fig.11a: a frequency-to-voltage converter using a voltage-to-frequency converter in a phase locked loop (functional inversion by feedback loop).



Nominal time constant:-	Capacitor	Resistor
τ	C_T	R
0.1s	0.1	1.0MΩ
0.2s	0.22	1.0MΩ
0.5s	0.47	1.0MΩ
1.0s	1.0	1.0MΩ

Fig.12: block diagram of a "leaky integrator" type ratemeter or averaging frequency-to-voltage converter.

OP AMPS Explained

time constants have passed), the current leaking away from C_T must be equal to the average current being dumped into it. So:

$$fq = V_T/R$$

$$V_T = f(qR)$$

Thus, in order for the circuit to function correctly, qR must have a constant value. To make q a constant, the precision pulse generator must be carefully designed using stable components. It should also produce a output voltage swing that is larg compared to any expected variations i diode forward voltage drop.

It is also important that leakag currents from C_T, other than throug resistor R, be kept quite small. Include here is the input to amplifier Q1 and th diode leakage current.

With these precautions the outpu

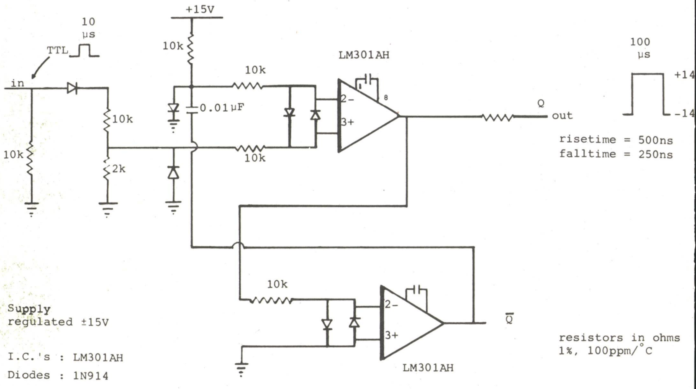


Fig.13: this pump pulse generator accepts a TTL pulse input and delivers a precision 28V pulse output.

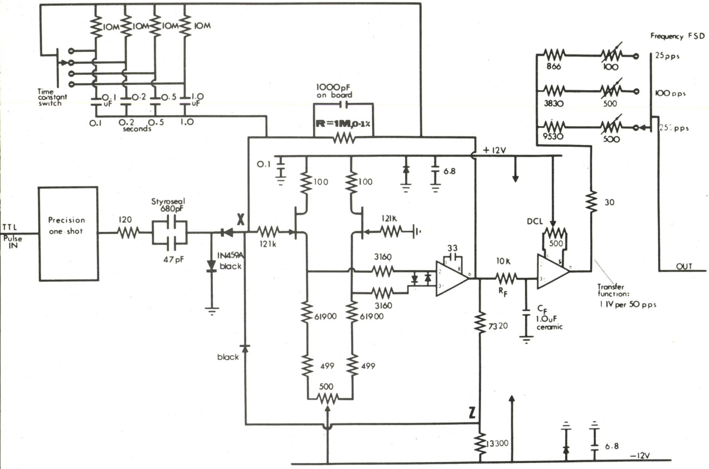


Fig.14: Detail of leaky integrator ratemeter, or averaging frequency-to-voltage converter (see also Fig.12).

voltage is directly proportional to average input frequency. The time constant of this statistical averaging process is given by the product (C_TR). Because V_T does not depend on C_T, that capacitor does not need to be a particularly accurate component.

Precision pulse generator

Because a pulse from a TTL gate has slightly different on and off voltages at different temperatures and is only a few volts high, the precision pump pulse generator of Fig. 13 is employed to deliver an accurate 28 volt pulse. The circuit is, in fact, a 28 volt "one-shot" or monostable square wave generator, and uses LM301AH integrated circuits instead of transistors for high open loop gain. The two op amps are wired as comparators, their outputs switching high and low to deliver an accurate 28V pulse. The rise and fall times are 500 and 250 nanoseconds respectively, while the pulse length is $100\mu s$.

Ratemeter circuit

Fig. 14 details the full ratemeter design. Do not fret, most valued reader, it is not as complicated as it looks.

To make life easy, let us look at both Fig. 12 and Fig. 14 together. The (680 + 47) pF capacitor from the precision one-shot forms the input capacitor C_i, while black 1N459A diodes, chosen for their low leakage characteristics, are used to block the positive pulses.

Next, we have a dual junction-FET source follower, the output of which is fed via two 3160Ω resistors to an LM108AH integrated amplifier. This IC and the FET together form the integrator amplifier Q1. By this means, we provide ouselves with a compound amplifier which has all the desired characteristics.

In particular, the input impedance is very high (more than 10^{10} ohms), while the input leakage current is only 10 picoamps.

Note that four different values of C_T can be switched in to provide four different time constants — 0.1, 0.2, 0.5 and 1 second. The 10MΩ resistors prevent switching spikes by keeping the capacitors charged to the same level. If the capacitors are remote from the PC board, an extra 1000pF capacitor should be mounted directly on the board to ensure stability.

The chosen capacitor, the resistor R, the dual FET and the LM108AH constitute the "leaky integrator" stage.

A circuit idea that you may not have seen before involves the 7320 ohm/13,300 ohm voltage divider network and the diode connected between point Z and the integrator virtual earth point X. These components are installed to prevent the integrator stage ever being driven into saturation by too high an input frequency. Too large an output turns point Z positive, thus causing the diode to conduct and reduce the stage gain.

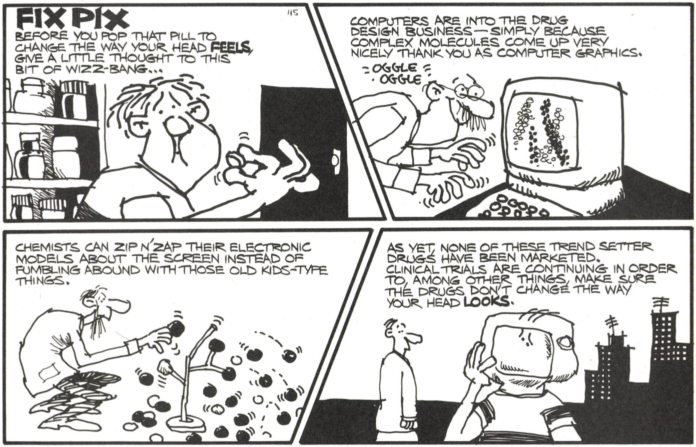
Not that saturation hurts anything; it's just that an integrator, once driven into saturation, may take a long time to recover after the overdrive is removed, thus causing a "dead time" in output.

The last stage is a simple voltage follower (gain = +1) which provides a low output impedance to drive the final range attenuator. This stage uses an LM110H op amp and includes low pass filter R_FC_F to remove any last traces of pump pulses in the output.

The overall transfer function for this circuit as 1.10 volts per 50 pulses per second, accurate to 0.2%. The circuit is supplied by well regulated ±12 volt rails while the resistors should be metal film 1% types.

Next month we will look into more fascinating aspects of operational amplifiers.

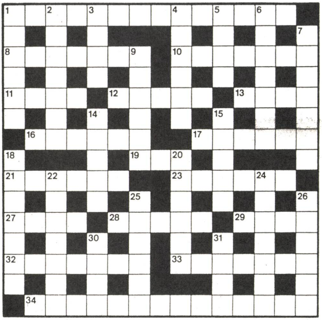
emerson's out of this world


FIX PIX
115
BEFORE YOU POP THAT PILL TO CHANGE THE WAY YOUR HEAD **FEELS**, GIVE A LITTLE THOUGHT TO THIS BIT OF WIZZ-BANG...
COMPUTERS ARE INTO THE DRUG DESIGN BUSINESS — SIMPLY BECAUSE COMPLEX MOLECULES COME UP VERY NICELY THANK YOU AS COMPUTER GRAPHICS.
OGGLE
OGGLE
CHEMISTS CAN ZIP N'ZAP THEIR ELECTRONIC MODELS ABOUT THE SCREEN INSTEAD OF FUMBLING ABOUND WITH THOSE OLD KIDS-TYPE THINGS.
AS YET, NONE OF THESE TREND SETTER DRUGS HAVE BEEN MARKETED. CLINICAL TRIALS ARE CONTINUING IN ORDER TO, AMONG OTHER THINGS, MAKE SURE THE DRUGS DON'T CHANGE THE WAY YOUR HEAD **LOOKS**.

OCTOBER CROSSWORD

ACROSS

1. *PVC coil? (10,4)*
8. *Leads. (7)*
10. *Permit to operate a transmitter. (7)*
11. *Part of a battery. (4)*
12. *Radio-navigation system. (5)*
13. *A word of the phonetic alphabet. (4)*
16. *Dimension ratio for a TV picture. (6)*
17. *Hold a video picture. (6)*
19. *A rectifier which is silicon-controlled. (1,1,1)*
21. *Insulating material. (6)*
23. *Electronic phenomenon. (7)*
27. *Vent in a speaker housing. (4)*
28. *Feature of almost every conductor. (5)*
29. *Valve. (4)*
32. *Said of an even field, etc. (7)*
33. *One of a series of programs. (7)*
34. *Communications conductor. (9,5)*



DOWN

1. *Apply a signal to a circuit. (6)*
2. *Obtains signal data. (7)*
3. *These are detected, to some degree, by a polygraph. (4)*
4. *Operational state of a motor, etc. (2-4)*
5. *Place for part-time training! (4)*
6. *Holder for small components. (3,4)*
7. *Pulse detector. (7)*
9. *Circuit problems. (6)*
14. *Sub-atomic particle. (5)*
15. *Term for the motion of electrons. (5)*
18. *Increases voltage. (5,2)*
20. *Control at a distance. (6)*
22. *Magnetic material. (7)*
24. *SI unit. (7)*
25. *It's an infrared sensation! (6)*
26. *Remove an item from a computer file. (6)*
30. *Audio signal. (4)*
31. *Record. (4)*

SOLUTION FOR SEPTEMBER

P	O	T	E	N	T	I	O	M	E	T	E	R		D
L		I		A				A		W		E		A
A	D	D	E	N	D	S		T	R	I	M	P	O	T
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O		M		E		E		O		R		X		C
P	I	P	S		B	R	O	W	N		E	C	H	O
P		L		L		N		A		A		I		M
I	S	O	T	O	P	E		Y	P	L	A	T	E	S
N		D		B		S				V		O		A
G		E	L	E	C	T	R	O	M	A	G	N	E	T

Sheridans Smash the Price Barrier!!

Hirschmann Quality

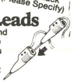
Flexible Probes

Red or Black (Please Specify)

This flexible probes are the ultimate. Powerful 'grabbing' probe end and superflexible shaft make means they can get into all the tight spaces. Give your multimeter a set today!

$6.85, +10 $6.20

1mm Test Leads



Red or Black (Please Specify)

1mm plugs (stackable) and test lead of super flexible wire. Great for prototypes and testing. There isn't a technician than shouldn't be using it.

$7.30, +10 $6.60

Fully Protected Bananas

Red or Black (Please Specify)

These superb banana plugs incorporate an automatic sliding cover. Great protection against shorts or high voltage. Top quality construction.

$4.50, +10 $4.00

2mm Test Lead Same as 1mm but bigger!

Red or Black (Please Specify)

$6.60, +10 $6.00

Very Pointy Test Prod

Great for very fine test point work. Takes banana plug in back.

$2.00, +10 $1.80

1mm sockets

Red or Black (Please Specify)

Suit 1mm plugs. Fully insulated chassis type. 90c, +10 80c

1mm plugs

55c each, +10 50c

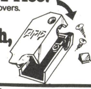
Audio Leads Knoockout

4 x 6.5mm jack plug to 1 x 5 pin DIN plug. 6 foot lead. We need the room so out they go! The connectors alone are worth over $4.00:

only $1.00, 10 for $8.00

9 Pin 'D' Connector Cover Under ½ Price!

Scoop of AMP 'D' covers. Quality!



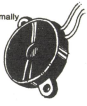
$1.00 each, +10 80c

25 Pin Snap Together 'D' Covers

Top quality from TRW. Half normal price!!

$2.00, +10 $1.80

Murata Piezo Buzzer



Top quality piezo, normally selling for $3.95. Thousands of uses.

only $1.95

Capacitors for Peanuts!!

Giveaway Bargains .1uF/160V Polyester Capacitors

$4.00 per 100

.39uF 160V Polyester

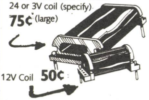
$5.00 per 100

100 of each type **$8.00**

Reed Coils at Magnetic Prices

Look what we found in the storeroom! These reed coils have millions of uses.

24 or 3V coil (specify) **75¢** (large)



12V Coil **50¢**

Tuning Gang Bargain

We have limited stocks of these rare beasties! 10-150pf air spaced/ceramic insulated tuning capacitors from Jackson.

Normally selling for $5.00. This month only:

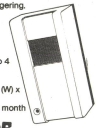
only $2.50 each

Alarming Specials

This month only!

Racal IR771 Infra Red Detector

These superb, fully professional alarm detectors are made by Racal. The design detects movement of infrared so there is no false triggering.



Range:
25ft
Power:
10.5 – 16V (15mA)
Alarm Output
Normally closed 1 to 4 seconds
Dimensions:
61mm (H) x 123mm (W) x 47mm (D)

Normally $122. This month

only $105

J.R.C. Mini MicroWave

Model NJH6007MA. This microwave doppler radar motion detector is perfect where the area to be covered has walls or petitions.

Variable sensitivity and controlled pickup angle enable tight control over pickup pattern.

Works from 11-18V DC with N/O and N/C contacts.

Normally selling for $105.00

this month only $89.00

Huge range of DIN connectors

We've got a huge range – including all the funny stuff, right angle connectors etc etc

Please phone with your enquiries

Huge Saving on 240-115V Stepdown Transformer

Ferguson TS115/240 fully approved 240 to 115V stepdown transformer at massive saving. 125VA and 5% regulation. Fused. Normally $62.00 but this month only:

$45.00 inc tax!!

Back by Popular Demand Pointmaster

This is the ultimate contoller/joystick. If you have computer games you need one today!! Suits VIC20/Commodore 64 and many others.

only $29.95

6 pin PC Mount DIN Sockets

Massive saving. Get in for your chop.

50c each, +10 45c

Philips Speaker Clearance!!

We are clearing out our stocks of top quality Philips speakers and crossovers at cost. Stocks are limited so be quick to avoid disappointment.

AD12100/M8	12in Woofer	1 only	was $65.00	now $35.00
AD12100/HP8	12in Woofer	1 only	was $80.00	now $45.00
AD12250/W8	12in Woofer	1 only	was $79.00	now $60.00
AD7060/W8	7in Woofer	4 only	was $21.00	now $17.00
AD5061/M8	5in widerange	2 only	was $15.00	now $12.00
AD70650/WP8	7in Woofer	3 only	was $24.00	now $19.00
AD2271/T8				
Tweeters				
10W Tweeter	10 only	was $3.25	now $1.50	
AD0162/T8	1in dome tweeter	12 only	was $13.00	now $10.00
Crossovers				
ADF500/ 4500/8B	3 way Xover	30 only	was $19.50	now $15.00
ADF1600/8	2 way Xover	50 only	was $11.50	now $7.00
ADF600/4500/8	3 way HiPerformance Xover	12 only	was $35.00	now $28.00
AD8081 CK	Ceiling Speaker	1 only	was $14.00	now $10.00

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699 6912**

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$50.00-$99.99 . . . . $7.00
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Trading Hours
Mon-Fri 9am-5.30pm
Thurs. 9am-7pm
Saturday 9am-12noon

Note: We accept both Bankcard and American Express. However we cannot give quantity discounts on Credit Card purchases or account orders. Minimum for account orders is $50.00
Minimum order is $10.00
All prices include sales tax.

Large and overweight items sent skyroad freight

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NEW ALTRONICS KITS

ETI'S MASTERPLAY

Home HiFi for the kids complete kit inc. turntable and every last knob, nut and bolt. Quite amazing sound reproduction (we mean it!) Be a hero and buy one for the family today.

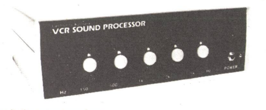
K 5040 Complete Kit (Timber base not supplied) **$79.95**

Please add $10 for Packing and Freight-**Speakers to suit** why not buy a pair of our super popular dual cone 8 inch C 2000's only $13.90 pair - refer to right hand side of this advert.

VCR SOUND PROCESSOR

SEE EA APRIL 1984

This fantastic kit is a Stereo Synthesiser and 5 stage graphic equaliser in one!!



Lets face it, the mono sound you get from your typical VCR is dull, colourless and boring. This is a crying shame, as these days, movie makers invariably add outstanding stereo sound and sound effects to the movies they produce. **Next time you visit a modern movie theatre you will see (hear!) what we mean.** Now a quite phenomenal enhancement to your VCR audio quality and impact realism can be achieved by feeding the Video sound O/P through your home HiFi system via. **EA's simply brilliant VCR Sound Processor.** Not only does it give simulated stereo but the inbuilt 5 stage graphic equaliser provides tonal depth for added realism and listening enjoyment.

Features -

- + Simple, easy to construct
- + Fully drilled/punched - no holes to drill
- + Quality screened front and rear panels provided.
- + Every last screw is supplied - even solder!

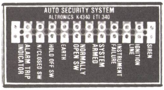
Value Packed

K 5820 .... **$55.00**
K 5821 Opt.Whistle Filter **$19.95**

+ + ALTRONICS BONUS + +

Our kit is supplied complete as illustrated with our superb H 0480 instrument case (not a tin box as our competitors supply) and at no extra cost. + + + + + + +

THE NEW ETI 340
CAR SECURITY SYSTEM KIT



This New ETI Design represents the ultimate in vehicle protection systems available today.

The Design uses stratigically placed Ceramic Resonance Mics to detect any tampering with your vehicle. **Features** + Automatic arming with entry and exit delays + dash mount led to indicate status of alarm + extra alarm inputs that can be wired to protect your boot, car HiFi etc.

Dead Easy to Install
+ Simple to transfer from Car to Car

Supplied complete with Two resonance Microphones, security window stickers and exclusive ABS case with drilled and silk screened front panel. We have also included a fully identified terminal block on the case to allow easy installation in your vehicle.

++**ADDED BONUS**++

This System includes circuitry to monitor your dash warning lights and will inform you of any abnormal condition.

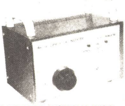
REF ETI APRIL 1984

K 4340 .... **$59.50**
K 4341 additional sensors . **$8.00**

GO ANYWHERE 12-240V POWER

300 WATT MODEL

Fully Drilled and Punched Chassis Superb Silk Screened Front Panel



($10 DELIVERY AUSTRALIA WIDE)

These great inverter kits enable you to power 240V appliances from a 12V DC power source. Tremendous for camping, fishing etc. Install into your Car, Boat or Caravan.

A fully regulated and overload protected design, featuring XTAL locked frequency. Use to power hi-fi, TV sets, even electric drills for short time periods.

MANY OF THESE KITS ARE NOW IN USE FOR EMERGENCY LIGHTING PURPOSES.

ALTRONICS KIT features :: Gold plated edge connector and PCB huss :: Low age rate XTAL :: Sockets for all IC's :: High Efficiency Transformer.

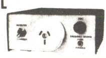
K6750..... (EA JUNE 82) ... **$199.50**

40 WATT MODEL

Suits small appliances, ie. Turntables, Tape Decks, Shavers etc. Variable frequency adjustment enables speed control of turntables. Works as a trickle charger when mains power is available.

EASY CONSTRUCTION :: VALUE PLUS

K6700..................... **$55.00**

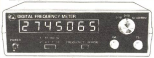


All 3 with laser cut screened front panels

★ ★ ★ ★

SUPERIOR QUALITY TEST GEAR KITS FROM ALTRONICS

ALL ALTRONICS TEST GEAR KITS COME COMPLETE WITH EVERY LAST NUT, BOLT AND SCREW EVEN IC SOCKETS SUPPLIED FOR ALL IC'S



DIGITAL FREQUENCY COUNTER

EA DEC. '81—FEB. '82
500 MHz, 7 DIGIT
RESOLUTION PLUS
PERIOD MEASUREMENT

This project is "so easy to construct", virtually all components mount on one single PCB, ensuring success even for the "not so experienced" constructor. Use of the latest LSI circuitry ensures impeccable performance from the completed unit. This is further ensured by our use of top grade components.

NOTE: ALTRONICS use only the specified intersil LSI—BEWARE of inferior kits that do not conform to the original design.

Frequency measurement to 500MHz (with optional Prescaler) in 3 ranges—0-10MHz, 0-50MHz, 10-500MHz. 4 gating times—0.01, 0.1, I, 10 seconds. **Period measurement** for accurate low frequency counts, 4 ranges—1, 10, 100, 1000 input cycles. Resolution 0.1us. **High input Sensitivity—** 10MV to 30MHz. 100MV at 50MHz @ 1MOHM input impedance, 200MHz @ 500MHz @ 75 OHMS input impedance. **Accuracy**—typically better than 0.005% uncalibrated.

EXCLUSIVE ALTRONIC KIT FEATURES:

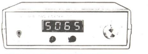
★ IC sockets provided throughout ★ *Low aging 10.000MHz XTAL.* ★ *Genuine Fairchild High Brightness FND 507 displays.* ★ *Quality ABS plastic case—deluxe front panel.* ★ *Complete kit as specified by EA includes instructions, all cables and every last nut, bolt and washer.*

K 2500 .... **$119.50**

DECIMAL POINT FOR K 2500
READ FREQUENCY DIRECTLY IN MHz and PERIOD IN US.
K 2502 .... **$7.50**

PRESCALER FOR K 2500
ALLOWS FREQUENCY MEASUREMENT TO 500MHz
K 2501 .... **$26.00**

DIGITAL CAPACITANCE METER



EXCLUSIVE TO ALTRONICS

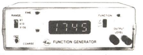
Each kit includes precision measured capacitors for accurate calibration of each range.

NEW DELUXE FINISH

We are pleased to announce the release of the Digital Capacitance Kit housed in our Deluxe H 0480 ABS Instrument Case.

This superb Test Instrument Kit now compliments our top selling Digital Frequency Counter and Function Generator Project Kit. Electronics Australia Project Measures capacitance of both polarized and non-polarized capacitors from 1 picofarad to 99.99 microfarads in 3 ranges ★ *Check values of unmarked capacitors, especially those little trimmers that are never coded* ★ Select precise values for filters and timing networks with ease.

K 2521 .... **Only $55.00**



FUNCTION GENERATOR

WITH DIGITAL DISPLAY

Sine, triangle and squarewave outputs 15Hz—250MHz.

The most essential piece of test gear (second only to a good multimeter) on any hobbyists bench is some kind of audio signal generator. This design utilizes the latest circuit techniques to produce stable,low distortion waveforms.

A truly versatile unit at a bargain price.

★ 4 digit frequency readout (eliminates tiresome dial calibration)—typical accuracy + 2% ★ 3 overlapping ranges x 1, x 10, x 100 ★ 600OHM Nominal Output—continuously variable 3MV—2.5V P.P ★ Distortion—sinewave : less than 0.7% @ 1KHz ★ Linearity—triangle wave : better than 1% @ 1KHz ★ Squarewave rise time—6V/uz maximum output ★ Amplitude stability—better than 0.1dB on all ranges.

With the exception of the display all components mount on a single PCB making this kit suitable for all constructors.

K 2505 .... **Only $85.00**

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ALTRONICS

Quality Imported Products Speedy Delivery Service

MICRON 30 WATT

This brilliant little 30 watt iron is just the 'bees knees' for the electronics hobbyist, electrician or home handyman. We searched the world for a low cost yet quality iron which met the criteria of ★ light-weight ★ screw in interchangeable tips ★ tip temperature maintains within the limits suitable for electronic work and also small household jobs ★ and of course fully S.E.C. tested and approved.

1000's Sold This Month Only

$9.50 T 2430

6A/400V DIODE BRIDGE

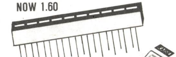
PRICE SLASHED

Z 0134............$1.75

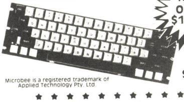
10 SEG. RED BAR GRAPH MODULE

SAVE 35% Z 0180 ~~$2.50~~

NOW 1.60



"MICROBEE KEYBOARD"



Microbee is a registered trademark of Applied Technology Pty. Ltd.

Now ONLY $19.50

Full 60 Key Qwerty Computer Keyboard exactly the same type that has been used with the famous Microbee Computer SPST Keys Complete with mounting plate. **(Fully Assembled).**

D1510

$29.95

Dual Cone 8 Inch Hi Fi Extension Speaker

Sensational Offer From only $4.95

Over 50,000 Sold Since 1976

Our brilliant C 2000 speaker is just the bees knees for use as a low cost HiFi extension speaker, PA or Background Music reproducer etc. **Don't let our incredible low price put you off** these are a quality product and have been approved for WA Govt. annual contract supply for schools etc. **Mount a pair of these in 1.9 cubic ft. vented enclosures and you will be simply amazed at reproduction.**

BE QUICK 1000 only at this price

	1-19	20-99	100up
C 2000	$6.95	$5.95	$4.95

MASSIVE 30 AMP RATED PANEL MOUNT FUSE HOLDER

Remember the hassle in providing high current circuit protection? The options are few — expensive industrial fuse assemblies costing $10 or more or circuit breakers (costing an arm and a leg). Well here is the answer — our nifty new panel mount fuse holder. **It's like a big, big brother to the 3AG Style.** The 10mm x 38mm fuses are an industry standard of course — naturally though, **ours cost somewhat less than industry standard prices.**
Panel hole size 15/16 inch is perfect although 1 inch or 25mm is OK.

Simple One Hole mounting — no more expensive panel cutouts, brackets.

	each	10 +
S6030 Fuse Holder..........	$4.50	$4.10
S5975 Fuse 20 AMP..........	$1.95	$1.85
S5976 Fuse 25 AMP..........	$1.95	$1.85
S5977 Fuse 30 AMP..........	$1.95	$1.85

OEM's — Please contact our Wholesale Dept for wholesale prices.

FUSE HOLDER 3AG

32 x 6.3mm Fuse

S6000......95c

10 Up......85c each

Buy 50 or more Just 60¢ ea.

FUSE HOLDER M205

20 x 5mm Fuse

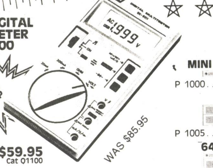
S5990......90c

10 UP......80c each

Buy 50 or more Just 55¢ ea.

☆ ☆ ☆ ☆ ☆ ☆ ☆ ☆ ☆

KAISE DIGITAL MULTIMETER SK 6100



IMPORT SCOOP

WAS $85.95

Now $59.95
Cat 01100

Check the specifications/features of this superb Digital Multimeter. **Autoranging** with manual override **Auto Polarity** displays — sign when probes reversed **overange indication** "Blink" and Buzzer warning **Low Battery Warning** BATT Sign shows. **Sampling Rate** 2 times SEC **Power Supply** 2 x A penlight batteries (300 hour continuous operation). **Fuse Protected,** spare fuse provided. **Zero Adjustment,** zero adjust button — a must if you change test probes. **LCD Display,** magnificent clear readout. **Inbuilt Buzzer,** available for continuity test, overload warning and switch warning. **Ranges** + / – 1000 V DC/600 V AC, AC and DC current, resistance 200 (Resolution .1 OHM) to 2000K OHM (resolution 1K OHM) in 5 ranges autoranging. **ACCURACY** ·5% DC, ·8% AC.

☆ PROTOTYPE SOLDERLESS BREAD BOARDS ☆

MINI STRIP 100 HOLES

P 1000.......... ~~$2.50~~ $1.95

640 HOLES

P 1005.......... ~~$9.80~~ $8.50

640 + 100 HOLES

P 1007.......... ~~$11.95~~ $10.00

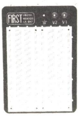
640 + 200 HOLES

P 1009.......... ~~$13.98~~ $12.00

NON-CORROSIVE
NICKEL ALLOY CONTACTS
RELIABLE FOR
50,000 INSERTIONS

There's a limit to just how many times you can resolder components while prototyping before you either destroy the component or lift a track from the vero.
These solderless breadboards enable circuits to be literally thrown together in an instant, yet all components remain reusable.
A necessity in all research laboratories to save on expensive development costs.

- Standard 0.1 inch spacings.
- Accepts all LSI'S, semis, transistors, diodes, leds and passives.
- 22-30 gauge solid hook up wire for interconnections.
- Boards are "Keyed" to enable easy expansion.

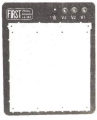


400 + 1280 HOLES

ACCEPTS UP TO 16 x 16 pin D.I.L. IC'S

SCREW TERMINALS FOR PS CONNECTIONS
P 1012

~~$29.50~~ $26.00



500 + 1920 HOLES

ACCEPTS UP TO 24 x 16 pin D.I.L. IC'S

METAL BACKING PLATE FOR SHIELDING OF SENSITIVE CIRCUITRY
P 1015

~~$45.00~~ $38.00

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$10.00 Heavy Heavy Service - All orders of 10kgs or more must travel express Road - Please allow 7 days for delivery.

Insurance - As with virtually every other Australian supplier, we send goods at consignees risk. Should you require comprehensive insurance cover against loss or damage please add 1% to order value (minimum charge $1) When phone ordering please request "Insurane".

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CHALLENGER: DSE's answer to IBM

Dick Smith Electronics has entered the market for "IBM standard" personal computers with the aptly named "Challenger" PC manufactured in the UK by Ferranti Ltd. The Challenger is one of the least expensive personal computers to claim compatibility with the IBM PC, with the bonus that it can be purchased in two parts.

PETER VERNON

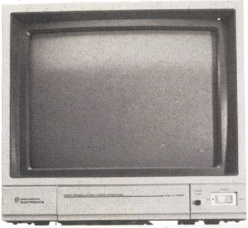
A Challenger computer consists of two units. Part A, the system unit, contains the 8086 microprocessor, 128K bytes of programmable memory and a ROM version of BASIC. It also provides a parallel printer port, three video outputs (RGB, composite video and modulated UHF) and a cassette interface. The system unit is big, measuring 53cm x 41cm x 10.5cm (W x D x H), and has a smoked perspex front panel which hinges down to reveal a space for stowing the keyboard. Normally the keyboard is plugged into the front of the system unit, just below the illuminated on/off switch at the right.

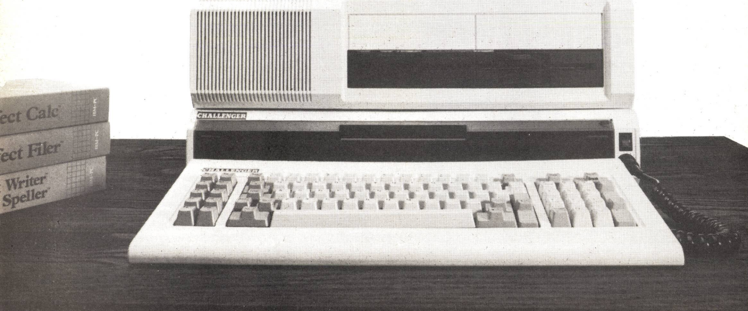
The keyboard is an attractive, low profile unit, with the keys in conventional typewriter locations except for the unusual provision of two RETURN keys, one just below the right hand SHIFT key and the other immediately adjacent. Accidentally pressing the RETURN key instead of SHIFT can cause problems. Ten function keys are grouped on the left side and the numeric pad and cursor control keys at the right, as on the IBM PC. The Num Lock key must be used to switch between cursor movement and entry of numbers, a particularly annoying necessity when using spreadsheet programs. IBM's non-standard placement of the RETURN key and the left-hand SHIFT key has not been copied however.

Overall the keyboard is usable but it is not the best feature of the Challenger. The light touch and long key travel combine to create a feeling of unsteadiness even though there were no problems of key bounce or miskeying. The space-bar on the review machine was also a little stiff, although a cure could be just a matter of use.

In itself the system unit is a powerful 16-bit computer with adequate memory and colour graphics capabilities. With a cassette recorder it can be used alone to learn programming, althought no pre-packaged software is likely to be available on cassettes. It is with the addition of the expansion unit, part B that the Challenger achieves its full potential and becomes a serious contender in the top end personal computer market.

Part B provides two double-sided 13cm disk drives, for 320K of storage each, three IBM hardware compatible expansion slots and two full 16-bit data bus expansion slots for specialised Challenger boards. Since the Challenger also has an RS-232C serial port built in





Differences between MS-DOS and Challenger DOS

The Challenger version of MS-DOS 2.1 differs slightly from PC-DOS 2.1. The major difference is the lack of some commands which support fixed disk drives.

Absent are:

ASSIGN — Permits Ver 1.0 programs which use a specific drive to be assigned to the hard disk.

BACKUP — Copies contents of hard disk to multiple (around 30) floppy disks.

RESTORE — Restores floppy disks created by BACKUP to the hard disk drive.

The MODE command of PC-DOS is also absent. Under MS-DOS, MODE allows the user to set the number of lines per inch and characters per line for a printer, the number of characters per line for the video display, to switch between IBM's monochrome and colour graphics adapters (PC-DOS 2.0 only) and to set operating parameters of the serial port.

MS-DOS for the Challenger provides SET80 and SET40 to control the number of lines on the video display, but there is no information in the manuals on use of other features. Obviously, there is no need on the Challenger to switch between colour and monochrome displays.

and provides the equivalent of the IBM colour/graphics adapter on the main board, the scope for expansion compares favourably with the IBM PC. With or without the expansion unit the Challenger's memory can be expanded to 256K internally. Maximum memory size is 640K, although increasing memory to this size would require the addition of a separate memory board inside the B unit. The double-sided disk drives provide twice the storage capacity of those of the IBM PC and are able to read and write disks formatted for use with MS-DOS 1.0, MS-DOS 2.0 and PC-DOS.

Adding the expansion unit to the Challenger requires some assembly work. The B unit is the same width and depth as the system unit but is 14cm high and designed to sit on top of the A module, connected to it by two edge connectors and a 240V power cord. Putting the two together requires finding and making these connections and then removing three plastic cut-outs from each side of the system unit to allow the two to be locked together. In its expanded form the Challenger is big and imposing, and at 24cm high, is too tall to support a video monitor at a comfortable viewing angle.

Internally, the Challenger is built with the precision of military equipment. There is a remarkable amount of unused space inside both A and B units, and the design could perhaps be improved by reducing the height of the two units. The keyboard storage space inside the system unit in particular seems an unnecessary refinement. On the plus side, the open design combined with a fan in the system unit means that there should be no problem with heat build-up.

When first switched on the Challenger performs a self-diagnostic program and then checks an internal switch to determine whether an expansion unit and disk drives are available. Depending on the setting of this switch the computer then either boots from a system disk or activates ROM BASIC.

The video display

Screen displays of graphics and text on the Challenger are identical to those of the IBM PC. Text can be displayed in either 40 column by 25 lines or 80 x 25 line formats in one of 16 colours with text, screen background and border colours selected with the COLOR statement. The colour codes are the same as those of the IBM PC. In the 80 column mode four video "pages" are available which can be written to and displayed independently of each other, while the 40 column mode allows eight screens to be stored.

Graphics are available in two formats, with either 320 x 200 or 640 x 200 screen resolution, selected by the SCREEN statement. The lower resolution graphics mode allows the use of four colours simultaneously, chosen from one of two "palettes" which include the current background colour. Any one of the 16 available colours can be used for the background display. The 640 x 200 graphics mode allows higher resolution displays but in black and white only. Colour is not available.

Although text and graphics cannot be mixed on the same screen, diagrams and charts can be labelled by defining your own text characters with graphics commands. Graphics are supported by the PSET, PRESET, LINE, CIRCLE, PAINT, and DRAW statements of Microsoft's Basic A while a limited form of animation is possible with the GET and PUT statements. GET stores a specified area of the screen image in an

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CHALLENGER

array which can be copied to new screen locations with the PUT statement.

The screen displays of the Challenger are well up to the standard expected of a computer in this class, although low-cost video monitors may be unable to produce a legible 80 character text display. This is a limitation of the video display unit, not the computer. If a domestic television receiver is used as the display device, best results will be obtained with the 40 column text mode.

Unlike the IBM PC, the Challenger provides both monochrome and colour graphics displays as standard. The equivalent of IBM's colour graphics adapter board is already built-in to the Challenger so no extra-cost options need to be purchased.

Software included

Programs for the Challenger are included in the price. A ROM-based version of Basic A is included in the system unit while the expansion unit comes with the essential Disk Operating System, or DOS, full Basic A and the "Perfect" series of word processing. Spreadsheet and database management programs are also supplied. Bought separately, these three programs alone would cost around $1,600, while IBM charges an extra $74 for PC-DOS and Basic A, with business programs starting at about $400 each.

The operating system of the Challenger is a version of MS-DOS 2.1 which differs slightly from both PC-DOS and the MS-DOS versions used by other IBM compatible computers. Exact differences are detailed in the accompanying tables, but as we shall see they do not affect the range of programs which can be run on the Challenger.

Compatibility

Compatibility is a vexed question. For copyright reasons, no computer from another manufacturer can be 100% compatible with the IBM PC. Most competitors in the PC market design computers which can use standard IBM programs, then add extra features to offset IBM's marketing advantages. Standard programs are those written to run under the MS-DOS operating system, using documented operating system calls. They do not use features which are peculiar to a particular machine. In this sense the Challenger is compatible with the IBM PC. Programs tested by this writer include the WordStar and Spellbinder word processors, the Lotus 1-2-3 integrated database, spreadsheet and graphics program, and the dBase II database management system. All worked as advertised.

Compatibility with "non-standard" PC programs is another matter. Some programs available for the IBM PC use the computer's internal control software directly, making calls to the ROM BIOS (Basic Input Output System). This method of writing programs is not recommended, as it usually means that the programs cannot be transferred easily to different machines. The famous "Flight Simulator" program from Microsoft is one example. In order to speed up the presentation of graphics on the screen, Flight Simulator directly accesses the video display circuits of the IBM PC. Many so-called "compatible" computers use different display hardware, and connot run the Flight Simulator program. The Challenger does not have this problem.

The extras

In addition to colour graphics the Challenger comes with a parallel printer connection and a serial communications port built in, as mentioned above. Connections for a light pen (for pointing at the screen) and a joystick are also standard rather than optional, but there are no details in the manuals supplied for the system unit or expansion unit. Documentation is one of the poorest features of the Challenger.

Although it runs at the same

continued on page 113

Challenger computer technical specifications

Processor	16-bit 8086
RAM	128K, expandable to 256K on board, 640K maximum
ROM	64K with Basic A and BIOS
Disk storage (with expansion unit)	Two double-sided 13cm drives, 320K each
Interfaces (with expansion unit)	Parallel and RS-232C ports, joystick and RGB, UHF and composite video outputs
Display	80 x 25 and 40 x 25 text 320 x 200 and 640 x 200 graphics
Sound	Internal speaker, seven octaves
Software	MS-DOS, Basic A and "Perfect" integrated series supplied with expansion unit.
Documentation	Poorly organised and lacking detail

Software for the DSE Challenger

Software for the Challenger is included in the price. It comes complete with DOS, full Basic A, and the "Perfect" series of word processing, spreadsheet and database management programs.

"Perfect Writer" is a powerful word processing program with a host of features which are correspondingly difficult to learn and use. Features include the ability to work with several documents at the same time, "split screen" editing of two files simultaneously and extensive print formatting and control functions. A spelling checker, "Perfect Speller" is also built-in.

The program is actually in two parts, one a text editor and the other a print formatting program which uses disk files. Text on the screen is combined with non-printing control characters which indicate formats such as columnar printing, indentation and other special effects, although it is possible to display text as it will be printed by "printing" to the screen before hard copy is produced.

Cursor movement, insertion and deletion of text, searches and block moves are performed with combinations of Control and Escape key sequences. Some commands require the user to hold down the Control key while pressing one or two letter keys, while others require the user to press and release the Escape key before pressing a second key. Commands introduced by Escape are generally larger versions of Control commands, so that, for example, Ctrl-F moves the cursor forward one character while Esc-F moves the cursor one word forward.

"Perfect Writer" comes with a book-length instruction manual and extensive on-screen tutorials and help files which ease the task of learning to use the program. Once the complexities are mastered it is an excellent program for preparing long documents with complex formats, with the added advantage of an installation procedure which allows the user to add customised printer drivers to make full use of effects such as bold-facing and proportional spacing.

A major advantage of the Perfect programs is that they form an integrated series. All the programs use the same control sequences and disk file formats, so once one program is mastered the user can transfer to another without learning new operating procedures. Disk files are stored in ASCII code and can be easily transferred from one program to another, allowing a spreadsheet created with 'Calc to be edited with Perfect Writer and updated with information from a Perfect Filer database.

"Perfect Calc" provides a spreadsheet of 52 columns by 255 rows, with eight columns and 24 rows displayed on the screen at any one time. A library of built-in functions is provided, including financial formulas and statistical operations, and users can add their own frequently used formulas for permanent reference. Large spreadsheets are no problem, as a form of "virtual memory" allows the program to swap information between memory and disk without interrupting operation.

Like Perfect Writer, 'Calc also has a "split screen" feature which allows two files to be used at the same time. Data from a spreadsheet displayed in the bottom half of the screen can be transferred to an entirely different spreadsheet displayed in the top half of the screen for instance. In addition, up to seven spreadsheet files can be in use simultaneously.

The companion database program, "Perfect Filer" is an information manager which also adds automatic "mail merge" capabilities to the "Perfect" series. It is a menu-driven program which provides facilities for creating, filing and searching information records and for generating form letters and mailing labels using the information stored in the database. One shortcoming of the program however, is that mathematical calculations cannot be performed between data items. There is also no programming language facility as in dBASE, so on the whole, "Perfect Filer" is the most limited of the Perfect series. It is adequate for small jobs and has the advantage of working with Perfect Calc and Perfect Writer, but it cannot take the place of more sophisticated database management systems.

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IBM expands in Australia

In operation only since June this year, IBM's Australian production of Personal Computers is already set to double and will shortly satisfy demand from Australia, New Zealand and South-east Asia.

Now that PC manufacture is well under way in Wangaratta, Victoria, work has begun on a second production line for PCs and this is expected to be operating early in 1985. The production lines are modelled on those at IBM's plant in Boca Raton, Florida. IBM's only other PC manufacturing facility is in Greenock, Scotland.

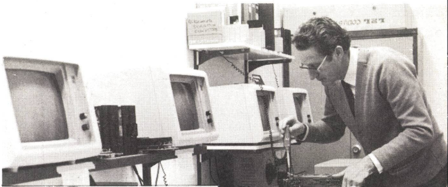
As a consequence of the increased PC activity, the IBM plant has been winding down production of Selectric typewriters. Future typewriter supplies will come from the IBM plant at Lexington, Kentucky.

IBM explains the reasons for the changes as follows. "Firstly, local demand for PC's is growing. Secondly, we will be exporting to IBM's South-East Asia Region countries by fourth quarter '84. And thirdly, there will be no more imports of the PCs or PC XTs currently announced in Australia from the plant in Boca Raton — we will be supplying all the requirements for this area.

The models initially produced at Wangaratta were the PC 1 and the PC XT. The former is the "standard" model with a single diskette drive and a main memory of 64 kilobytes. The XT adds a 10-megabyte hard disk and has main memory of 128KB. Two ne models were announced in June an they will be produced at Wangaratta to These models are essentially the sam except that in both cases the mai memory has been increased to 256KB.

The PC production line is essentially final assembly operation, taking ful built modules such as power supplie disk drives and completed printed circu boards and putting them all into th CPU case. Then it's just a matter testing and packing.

The parts most in danger of shippi damage, the disk drives and hard dis units — undergo preliminary testing soon as they arrive at the plant. Togeth with other parts, such as integrate circuit boards, they are then collecte into "kits" which are assembled a undergo extensive testing in the proces



At left, a PC undergoes diagnostic chec while above, more PCs with option cards a tested at varying voltages.

Quality control is rigorous, from el tronic components to packaging a labelling, before finished PCs are shipp to IBM's warehouse in Sydney to orders.

IBM is aiming to have Australi companies supply at least 25 per cent the components for its Person Computers made here. Eventually, th could provide local suppliers wi

PCs plough down the line for run-in tests. At right, disk drives undergo testing with PC software routines.

business worth tens of millions of dollars a year. All the packaging supplies come from local sources. Hardie Containers supplies the cartons, while Olympic Duroflex provides the foam rubber inserts. Contracts let so far total approximately $500,000 per annum in value, and IBM now has around 10 components out for tender or under evaluation for the PC, including printed circuits, assembled boards, cable harnesses and a range of hardware items.

The Wangaratta plant also produces high quality copies of the PC's disk operating system (DOS) and self-diagnostics software. A special replicating machine is used to produce the copies of PC diskettes to fine tolerances and extremely high fidelity to the master disk. Special test equipment ensures that these IBM diskettes are error free.

Copied diskettes are sent to IBM's PC Software Manufacturing Department in Sydney where quality control inspection is carried out before the diskettes are forwarded to the contractor for assembly into the finished product.

In the meantime, Sydney-based companies are producing the other components including printed manuals, sleeves, binders, templates, labels, etc. These are forwarded to a prime contractor who carries out the final assembly. The finished product is shipped to Rosebery where PC Software Manufacturing carry out a final quality inspection.

So far IBM is producing the Basic and Guide to operations publications and the DOS software together with its related technical reference manual. There are plans to manufacture more PC software products in Australia as the demand grows.

Meanwhile, IBM's Software Development Support Centre (SDSC) in Sydney has been dealing with a flood of enquiries from local software houses eager to investigate marketing their products through IBM channels. Some 300 packages have been submitted for assessment.

The SDSC was established last October, Its mission, in the words of Dr Frank Barr-David, Director of Software Development, "is to put Australian software products into the world arena".

This applies not only to PC software but to programs for IBM hardware of all kinds. In fact the first contract, to Sydney-based Datec Pty Limited, was for extensions to configuration management programs running under IBM's MVS operating system for large computers. The contract was worth about one million dollars.

The first PC contract was with Attache Software Pty Ltd, also based in Sydney, for a suite of accounting systems. A special version of this package in its distinctive attache case is now used on IBM PCs in the US as well as Australia.

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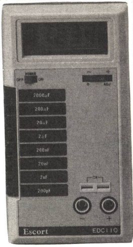

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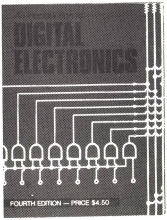

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50 and 25 years ago...

"Electronics Australia" is one of the longest running technical publications in the world. We started as "Wireless Weekly" in August 1922 and became "Radio and Hobbies in Australia" in April 1939. The title was changed to "Radio, Television and Hobbies" in February 1955 and finally, to "Electronics Australia" in April 1965. Below we feature some items from past issues.

Wireless Weekly 3d

October 1934

London — Melbourne air race: The Centenary Air Race will commence at Suffolk, England on October 20 and is expected to finish in Melbourne approximately two and a half days later. Competitors must pass through compulsory check points at Baghdad, Allahabad, Singapore, Darwin and Charleville.

This race is certain to prove the greatest and most spectacular in the history of aviation, and it is no exaggeration to say that the whole world will watch it with keen interest. It is, therefore, the more appropriate that it should be the subject of the greatest broadcasting "link up" ever attempted, namely, that of the three entire systems of England, Australia and America.

The controlling committee has arranged with Amalgamated Wireless for the establishment of wireless direction finding stations at Darwin, Charleville, and Melbourne, for the guidance of those who carry wireless.

UHF experiments: Since the characteristics of "centimetre" waves are similar to ordinary beams of light, they have an obvious advantage in that they may be directed like a searchlight. Experiments show that these waves may be reflected from metal surfaces just like ordinary light. Consequently, the transmitter of this super-short radio wave system utilises a parabolic metal reflector which concentrates the energy n the desired narrow path directly to the receiving point, where a similar reflector s used to pick up the transmitted energy.

Super-short radio waves only about 4 nches (10 centimetres) long, and of high power, were recently produced, and their effects demonstrated before a meeting of the Institute of Radio Engineers held in Philadelphia.

Developments in recent years have unmistakably indicated to engineers that exploration in the field of extremely short waves will open up a vast number of additional usable radio channels for communication and other purposes (for instance, the remote control of various devices).

World's largest radio show: More than two million pounds worth of radio goods has been sold at the 1934 Radio Show at Olympia, London.

There is no doubt that the Radio Show produced some novelties quite startling to enthusiasts, not least of which was the ten per cent reduction in prices this year. This seems to be coincident with an improvement in quality. In the words of an enthusiastic salesman, "a 1932 set is now only suitable for a museum piece."

An interesting development is that the names of the British and foreign stations are being printed on the tuning dials. All you have to do is turn the knob which moves an oblique line across the dial. When this line comes across the station you are seeking, the set is tuned to it.

RADIO TELEVISION AND HOBBIES 2/6

October 1959

Moon bouncers: A revolutionary radio communications system, using the Moon as a relay station, is expected to be in regular operation between the US and Hawaii before the end of this year.

Extremely high frequency waves, which cannot ordinarily be used because they do not follow the curvature of the earth will be used. They will be sent straight up and "bounced" off the Moon. It is the first step in using the Moon or an artificial satellite as a relay point.

Scientists anticipate that the space relay system would be largely immune from blackouts and other interference from phenomena of nature.

Bus monitor: Traffic congestion is a problem in most major cities. Today, more than ever, electronics is being called on to solve it. What's being done in London is one example.

That city's Transport Executive operates 500 bus routes with a fleet of 7,000 buses. To reduce bunching and irregular running of the buses, scanning units at several checkpoints detect their passage. The bus's number is relayed in binary form to the route display panel at the control centre.

The electronic indicator gives the bus operators a picture of bus distribution thus permitting early action in the event of service irregularities.

GE turboprop: Some idea of the advances which have been made in turboprop engine efficiency is given by a recent announcement from the General Electric Co.

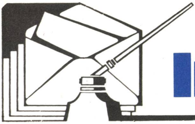
America's new T64 turboprop engine has more than twice the power-to-weight and consumes half the fuel of the United States' first tuboprop engine, the T31 which was developed in 1941.

Detailed technical information on the T64 was disclosed for the first time by General Electric and the United States Navy. The turboprop weighs 1,079lb and produces 2,570 h.p.

Colour TV tube: With patents already issued and assigned to it, Andromeda, Inc. of Kensington, Md. has its engineers busily working toward an early public demonstration of a new colour CRT and its associated receiver.

Heart of the system is a one-piece colour CRT with a single electron gun. However, the gun will simultaneously emit three electron beams so closely spaced as to minimise convergence and registration problems.

Advantages claimed include full compatibility with standard colour signals as transmitted at present, improved reception quality and receiver reliability, reduced service requirements and a sizable reduction ("at least 30 per cent") in the cost of the set.



Information centre

Venerable generator breathes its last

Over six years ago I built the Signal Generator described in the September 1965 issue of *Electronics Australia* and until a few days ago it worked faultlessly. Now it has gone completely haywire and I have no idea what the trouble is. The problems are:

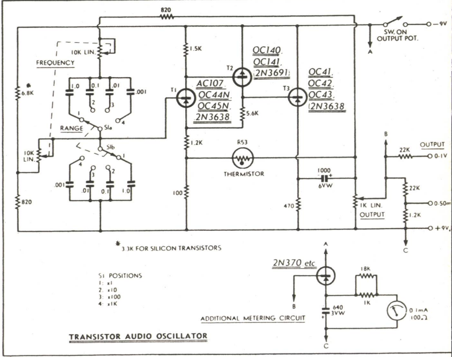
1. It will not work at all above 50kHz.
2. When switching from band to band, there is no output for several seconds.
3. The output signal builds up and dies away (best way I can describe it in words) about twice a second over most of the frequencies over which it now works, though the effect is most pronounced at higher frequencies.
4. Sine waves have a poor shape — one of the peaks is not formed properly and the "axis" is tilted over to the right. The thermistor is an RA53. I have tested it with an ohmmeter — on low resistance range, it initially measures 500Ω, then quickly drops to about 20Ω and keeps that value.

On the 1MΩ range it starts at about 500Ω, drops to a very low figure, then very slowly rises. Transistors are an OC44, AC127, AF115N. I am sure the CRO I used it with is quite OK. The generator used to give excellent sine waves right up to 200kHz (although the output had dropped relative to 1kHz somewhat) and had useful square waves right up to that frequency. Please can you help? (W.S. Brompton, SA).

- *What you have there is a "golden oldie" in the electronic sense. That project was our very first transistorised Wein bridge oscillator and as you have found, it was quite a reliable circuit. We have reproduced it above.*

By virtue of its simplicity there is not a lot which can go wrong. We suspect that one of the transistors or the 1000µF capacitor has become leaky.

Probably the quickest way to repair the unit would be to replace all the transistors and the suspect capacitor. While OC44s are still obtainable, the other germanium types are not, so the best way to do it would be to use modern silicon types. T1 and T3 can be BC328 while T2 can be BC338. If you do this you will have to also change the 6.8kΩ resistor to 3.3kΩ, as noted on the circuit diagram.



This signal generator circuit was described in our September 1965 issue.

You do not say whether you also incorporated the optional metering circuitry but if you did, this portion of the circuit should be checked also. Since you have an oscilloscope, we suggest that you disconnect the metering circuit to check whether it is having any effect on circuit operation. If the 2N370 proves to be defective, it can also be replaced with a BC328.

Auto-fade control for sound mixer

I have recently built the auto-fade section of the Movie-Mixer featured in the September 1978 issue of *Electronics Australia*. The circuit has been incorporated into a more complex mixer of my own design.

The auto-fade operates quite satisfactorily, except that both adjustment pots must be fully advanced to obtain any significant separation between music and voice signal components on the output end of the device. Separation at that setting is reasonably satisfactory, but I would prefer the depth control pot to have some flexibility — say to commence separation from about half-way in i travel.

I have substituted a 3819 FET in a attempt to modify the control, and ha used a 9V supply but to no real effect. tried shorting out the 10µF electrolyt capacitor in the circuit above the aut fade level pot, in an effort to increase t passage of music signal to earth (which the function of the FET).

It would be greatly appreciated if y could advise me regarding my proble and hopefully offer a solution that wou make a most useful device even better operation. (P.A. North Balwyn, Vic).

- *Operating the circuit from a 9 supply instead of the original 16.5V r is possibly the reason why the circuit less effective than it should be. You ha effectively reduced the amount of b that can be applied to the gate of t FET — it may not be "pinched off" as is supposed to be when no signal present.*

By the way of example, with t original 16.5V rail, the maximu negative DC voltage applied to the F gate would be 8.8V. With a 9V rail, t equivalent figure is only 4.8V and t may not be enough to fully turn many FETs.

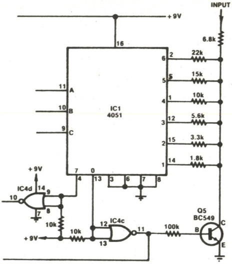
The other point to remember is that the rectifier circuit (which provides the DC signal to turn on the FET) needs a fairly large signal of several volts peak-to-peak. If you are using a 9V supply you may not be getting enough drive.

Remote volume control for TV set

Recently I have constructed your "Remote Infrared TV Sound Control" and am now experiencing some application problems. Having made the modification to accommodate a DC volume control (EA February 1983), I varied your suggested resistors to give eight even steps: 0, 1.3, 2.5, 3.8, 5.5, 6.5, 7.8 and 9.3 volts. Remote repeatability of these voltages is spot on.

Working 100% on the bench I transferred the remote control to my National TV set, model TC-2634 — no go! Power to remote board, 12.3V DC. Board to TV connections double checked. Volume control voltage range 0-11.2V. At zero, no volts and no volume. The problem is that, having set the volume control, the remote control has very little voltage control range. (K.C., Aitkenvale, Qld).

● *Examination of your TV schematic shows that the volume control is actually wired as a potentiometer rather than a rheostat, the case covered in our February 1983 article. Also, the sense of your volume control is different in that the DC input is maximum for maximum volume.*



The output circuit for the Remote Infrared TV Sound Control (Feb, 1983).

In view of this, the remote circuitry needs to be wired differently. The 6.8kΩ resistor from the remote should be wired to the wiper of your set's volume control. Then, the variable DC input to your set should be taken from the collector of Q5. Now at the minimum volume setting, Q5 will be on. This means that the up/down buttons on the transceiver will have to be reversed. It may also be necessary to change some of the other shunt resistor values to get the control action you desire.

The relevant part of the remote volume control circuit has been reproduced on this page.

Challenger Computer...ctd from p107

4.77MHz clock speed as the IBM PC, the Challenger is slightly faster than the IBM machine. The 8088 microprocessor used in the IBM PC was designed at the beginning of the transition from 8-bit to 16-bit computers, and sends data out to memory in 8-bit chunks. The 8086 processor used by the Challenger is identical to the 8088 except for the fact that it transfers data in 16-bit chunks. The result is an approximate 15% increase in processing speed. The user may not notice this slight difference when using applications programs, but it does have an important consequence when the Challenger is expanded. Memory chips used for the expansion must be the faster type, with an access time of 150ns rather than the standard 250ns type.

In conclusion

Feature for feature, the Challenger is a more attractive machine than the IBM PC. The only disadvantages are the awkward installation procedure, the rudimentary operating manuals and the possibility that IBM may change the PC operating system so that "compatible" machines cannot use new IBM PC software. This last disadvantage of course applies to all IBM-compatible machines on the market. According to DSE the company will rectify the problems with documentation, but in the meantime any of the wide range of books on the PC and the MS-DOS operating system are applicable.

At $995 for the System Unit and $1995 for the Expansion Unit, our conclusion must be that the Dick Smith Challenger is a winner. It is an attractive unit that offers IBM compatibility for around half the price of the IBM PC.

For further information on the Challenger, contact your nearest Dick Smith Electronics store.

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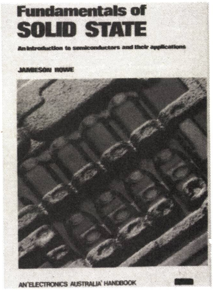

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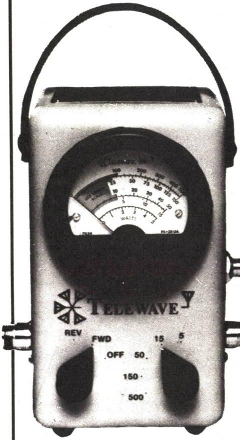

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Information Centre . . . ctd

Mains power for Wheatstone Bridge

I would like to build the Wheatstone Bridge of February 1983 provided that I could power the amplifier from a mains supply. I have in mind for this purpose a small voltage doubler unit. Would you inform me if this idea is feasible.

I ask this question because of my experience with the Volt-Ohm Meter of December 1968 when I tried to power it from a mains supply. The meter went up scale and stayed there when the range switch was at the low volts point and with no input. (N.S., East Bentleigh, Vic).

● *We have not tried this circuit with a mains power supply and there is a risk that hum could be introduced into the circuit. If this happened, it would not be possible to get a good null. Further than that, we are unable to comment.*

Substitute SCR for battery charger

I have recently constructed a battery charger described in *Electronics Australia* in October 1971.

The only real problem I have had is finding a suitable component for SCR No. 2. The items given in the article are either a "C20D" SCR or a "BT101/300R" SCR. As I have been unable to find any evidence that these devices are still available, nor any data applicable to them, could you please suggest a suitable substitute for SCR No. 2 which is currently available.

I have tried a C164D SCR for SCR No. 2 with passable results, but the result is that the SCR ceases to sustain conduction once the connected battery terminal voltage reaches 12.5V. I have also found it necessary to change the timing components of the "PUT" from 18kΩ/0.1μF to 1.8Ω/1μF to ensure reliable firing of the SCR No. 2 (C164D) with a battery load. Operation with a resistive load from "zero" ohms to 10 ohms is normal.

The circuit provides 7.5V in the 6V position, and 15.5V in the 12V position and current limiting occurs at 4 amps as indicated in the set-up procedure. The voltages were obtained with the suggested battery equivalent circuit, ie, 100Ω/1000μF. Any assistance with a suggested component for SCR No. 2 would be appreciated. (D.H., Hazelmere, WA).

● *The direct equivalent is the C220D which is rated at 10A and 400V. Since the charger is capable of supplying only up to 4A, the C122E or C122D SCR rated at 8A would also be suitable. The latter SCR is available cheaply from most electronics supply stores.*

Modifying the Guitar Effects Unit

I have been an avid reader of EA for the past 15 years and during that time have constructed several of your projects, the latest of which is the Effects Unit described in June 1983.

1. There seems to be a good deal of audible hiss (clock noise?) which is easily registered by a VU meter. This noise is greatly accentuated when echo delay is set at or near maximum.

2(a). Vibrato functions normally at both frequencies. However, when used in conjunction with echo there is an audible pulsing "whistle" present at maximum vibrato depth.

2(b). Vibrato operation is affected by the echo delay setting.

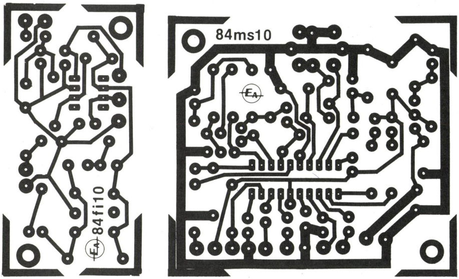
3. Is it possible to increase the amount of analog delay to 50, 75 or perhaps 100ms by inserting one or more BBDs in series with the existing MN3001? If so could I use the same clock or do I need an extra CMOS clock for each BBD? Naturally I would have to make up lost gain by including an LF351 with each extra BBD.

The reason for the above modification is of course to increase delay and give a more profound effect — particularly in the single echo function.

I am trying to create firstly a "chorus" effect which I imagine is vibrato on a delayed signal combined with the original signal. Secondly I have seen small electronic repeater/delay units used by guitarists which provide an effect originally achieved by passing an endless magnetic tape over a series of heads. This resulted in multiple (and decaying) signals of around 200-500ms delay.

I realise that units which achieve all of the above and more are available commercially for large sums of money. Is the cost directly related to the number of BBDs incorporated in the design or merely a result of clever marketing tactics? Are there other BBDs available which are capable of providing usable delays greater than 25.6ms? (up to 1.6s).

AM Stereo Decoder . . . ctd from p43



Here is actual size artwork for the two printed circuit boards.

The rest of the conversion is fairly straightforward and involves disconnecting the existing AM tuner output at P22 and running new output connections P40 and P41 from the decoder to the selector switch S1. Note that the existing link between P40 and P41 on S1 must be removed.

The indicator LED can be mounted on the front panel, adjacent to the AM designation for the selector switch (see photograph). If you wish to use whistle filters, then the February 1979 design should be duplicated and the two filters interposed between the decoder outputs and the selector switch. Don't forget the setting up adjustments as before.

Finally, would readers please note that we are unable to offer advice on adding this decoder to specific commercial tuners.

Reference: "C-QUAM AM Stereo Decoder", Marty Bergan (Motorola Inc), *Radio-Electronics,* January 1984.

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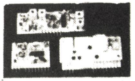

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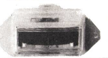

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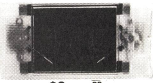

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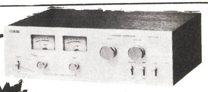

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HERE'S OCTOBER ISSUE FOR HUGE CLEARANCE OF VALVES — HUNDREDS OF TYPES

Information Centre . . . ctd

. It was interesting but frustrating to xperience the strange effect of isproportionate frequency response vhen the unit was set at near maximum everb depth. Stranger still was the effect chieved with the above setting whilst he echo delay was altered.

It is fascinating to me that a signal requency can be altered using a otentiometer. Unfortunately the ariable pitch is only temporary. If omehow it could remain permanent it vould greatly simplify the problem of reuning an electric guitar to match other nstruments. (J.D., Ballarat East, Vic).

● *Unfortunately the only remedy for he audible hiss and pulsing whistle resent in your Effects Unit is to select a igher clock frequency. Obviously, this vill lead to reduced delay. The only olution for this type of circuit is to use a umber of BBD devices connected in eries, as you have suggested.*

An alteration of the vibrato haracteristic is to be expected when the cho delay setting is altered.

Your scheme for connecting two N3001 devices in series appears to be asically sound, although you would eed to ensure that the correct bias oltage was maintained at the input of he second device. Assuming, however, hat you were to increase the clock requency above 20kHz to reduce noise, wo MN3001s may not provide the delay ou require.

Where delays of more than a few undred milliseconds are used, the best pproach may be to use a digital delay etwork. In this way, signals can be tored digitally (ie, using RAM) for any ngth of time.

With regard to chorusing, a number of elayed signals are mixed with the riginal signal in the same way as our echo effect. Usually, three or four "echo" paths are used. Only a fairly brief delay need to be used, although the actual delay must be different for each echo, ie a different clock used for each.

The change in signal frequency which results from altering the delay setting can, unfortunately, only be temporary. The frequency can only differ from the original whilst the clock frequency is changing.

Low frequency noise on cassette tapes

I would like to know, if you can tell me, what is the purpose of the low frequency pulses, hum or whatever it is called, that is found on the beginning and end of some audio pre-recorded cassettes.

It causes woofer speakers to jump like mad. Is it some form of sync pulse for recording purposes and if so, why can't it be removed prior to sale? (T.W., Broken Hill, NSW).

● *We have not experienced this problem. Perhaps a reader can throw some light on the subject.*

Notes & Errata

OP AMPS EXPLAINED, PT. 5 (July 1984, File 8/DT/140): The formula given for calculating Cx on page 99 is incorrect. The correct formula is:

$$Cx = 33/(\text{closed loop gain})\ \text{pF}$$
$$= 33(Ri)/Rf\ \text{pF}.$$

NOISE SIMULATOR (June 1984, File 1/MS/30): The parts list incorrectly shows 1 x 470kΩ and 4 x 100kΩ resistors. This should read 2 x 470kΩ and 3 x 100kΩ.

Thermocouple robe . . . from p55

ver the whole range.

Final assembly consists of shoeorning the PC board and battery into he case. The battery should be insulated rom the circuit board components with thin layer of foam rubber.

A number of thermocouples are ictured in this article. If you require a robe type thermometer it can be quite xpensive, depending on its construction. or many temperature applications a imple welded junction with fibreglass eads is all that is required and it is nexpensive. Such a cheap thermocouple an be readily attached to a emiconductor case or heatsink and good hermal contact is assured with a dab of eatsink compound.

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Hi-Fi Review — continued from p33

jolting the player when it was playing a disc. While it was possible to make the tracking mechanism jump across tracks, it required a heavy blow for this to happen. Under normal household circumstances, mistracking should never occur.

In summary, we were very impressed with the performance of the Philips CD303 compact disc player. It is an excellent performer in all respects, mechanically and electrically quiet, and a delight to use. At a recommended retail price of $799, we have no hesitation in commending this unit to our readers. (J.C.)

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6AG7
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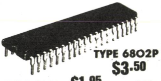

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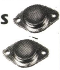

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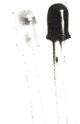

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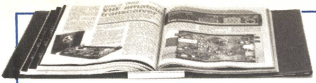

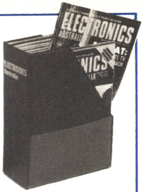

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Telephone 570 7000.
121 Forest Road,
Hurstville 2220.
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Telephone 211 0816.

RCS Radio Pty Ltd
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Telephone 587 3491.

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Telephone 645 1241

VIC.

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Jemal Products
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Kewdale, 6105.
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N.Z.

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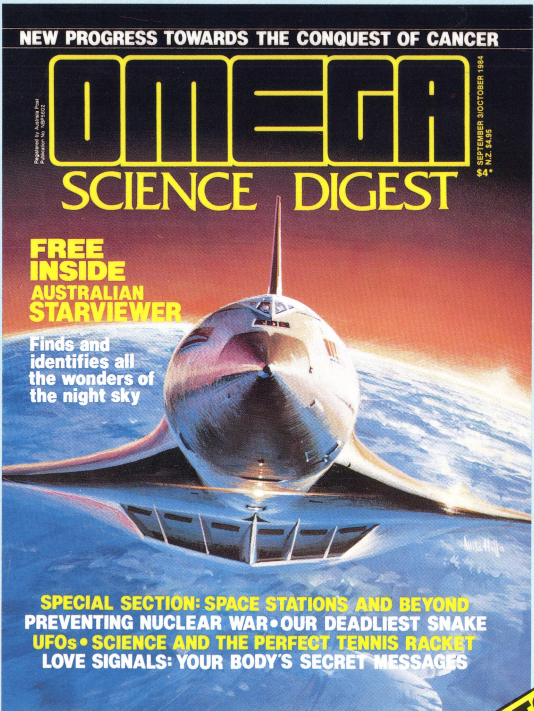

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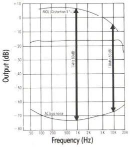
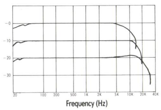

Dynamic Range and Frequency Response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